APPENDIX A

Historical Summary of Manufacturing Operations and Facilities

1.0 Site Background and History

The various historical configurations of the Facility and the activities conducted at the Facility are important to the investigation of nature and extent of contamination, assessment of human health and ecological risks, and the identification of remedial requirements. Therefore, the following text and associated tables and figures summarize the activities and Facility configurations. This information has been used to identify known and potential chemical release areas and migration pathways. That information has been incorporated into Remedial Investigation (RI) Work Plan, and in particular, to the field sampling and analysis plan (SAP) for the identification of sampling locations and appropriate analytical parameters.

1.1 Manufacturing History and Products, Raw Materials, Wastes

This section summarizes the manufacturing history by identifying the products, raw materials, processes and wastes that were associated with manufacturing activities over time. Following this discussion of the manufacturing history is a discussion of the structures associated with the operation of the Facility as well as the waste disposal systems and associated features.

Manufacturing activities were conducted at the Site from 1953 until 1986 when manufacturing operations ceased. The facility expanded incrementally (additional buildings were constructed) as additional products and processes were added and as processes were modified. The facility produced chemical products for use in the rubber and plastics industries (particularly nitrogen blowing agents, but also including blowing agent activators, polymerization initiators, antioxidants/stabilizers, retarders, processing aids, phthalate plasticizers, and chemical intermediates) and it also produced phenolic resins (phenol-formaldehyde resin). Available information indicates that the latter products were not associated with any substantial amounts of liquid waste materials. Two particular nitrogen blowing agents, Opex® and Kempore®, were by far the largest volume products manufactured at the facility. Both products were manufactured from the 1950s through the 1986 when operations ceased.

Table 1 presents a chronology of the major manufacturing operations (and associated product lines) that were conducted at the facility. The table is organized by the major manufacturing products for the facility. Former manufacturing operations were conducted in Plant A, Plant B, Plant C-1, C-2, C-3, Plant D (D-1 (used as a process plant and as a Pilot Plant), D-2, and D-3), and the Pilot Plant (Figure 1). Table 2 presents a summary of the manufacturing products for the facility, including the identification of raw materials and waste products for each major product and the disposition of the waste products. Table 3 identifies the buildings that have been located at the facility over time. The following section identifies the physical configuration of the facility and discusses the buildings and other structures (such as storage tanks, waste disposal processes and associated structures and features (such as process sewers), and other site features (such as transformers) that are of potential interest form a site investigation perspective.

2.0 Physical Configuration and Site Structures

Figure 1 shows the configuration of the facility at the time that operations ceased in 1986 and it also includes several historical waste disposal features that are no longer present at the Site. Figure 2 identifies storage tanks, septic tanks, and transformers that existed during the facility operations. Figure 3 is a photograph of the facility in 1986 near the end of its operational life. That photograph identifies buildings by name and by building number.

2.1 Buildings

The buildings at the facility included chemical manufacturing/processing buildings, warehousing/storage buildings, boiler plants, maintenance buildings, pump houses, office space, and laboratory space. The manufacturing/processing buildings included Plants A through D and Pilot Plant. The buildings are identified in Table 3 and the locations are shown in Figures 1 and 2. Figure 3 is a photograph showing the appearance of those buildings in 1986 prior to facility shutdown.

The buildings at the facility were constructed and operated over time. The facility expanded from 1953 until approximately 1972. There were few additional buildings constructed after that time. The building currently known as the current Plant B Treatment Building was the last building to have been constructed. The manufacturing buildings are discussed in the next subsection. The initial configuration of the facility (for Opex® production) included Buildings 1, 2, 3 (three storage buildings), 4 (office/lab -including Boiler House “A”), 6 (Plant A) and 6A (ice house). Plant B was constructed and began production of phthalate plasticizers in 1955 (also produced HEXA for the Opex® process until 1970). The Plant B Tank Farm was also in place by 1955 and the Boiler House was also in place by April 1955. Plant C-1 was constructed and began Kempore® production in 1956. Plant C-2 was constructed and processed Kempore® solids in 1962. Plant C-3 was constructed in 1962 and produced Hydrazine for the Kempore® process. Plant D was constructed in 1968 – 1969 and began production of Nitropore OT in 1969 and Nitropore OBSH in 1970.

The original office building and lab (Building 4) were not used for chemical production activities. Boiler House "A" was immediately adjacent to this building as part of the initial facility configuration. The general purpose building (Building 5) housed the Superintendent's office, laboratories, and the Pilot Lab (also referred to as the Pilot Plant). An additional office building (Building 4A) was used solely for office space. The butler building (Building 12) and the Guard Shack were not used for any manufacturing activities.

Three buildings (Buildings 1, 2 and 3) built early in the facility's history were used for storage of finished product materials that were produced at the facility. The West Warehouse (Building 15 and 15A) was built in 1964 as was the East Warehouse (Building 16). These buildings were used for storage of raw materials and products. In addition, Hi-Lite fertilizer was formulated in the East Warehouse from 1966 to 1968. The raw materials for this process included peat, urea, potash, diammonium phosphate, and ammonium sulfate.

The Maintenance Shop/Boiler House (Building 10), Stock Room (Building 10A), and the Pump House (Building 11) were not used for any chemical manufacturing activities. The fuel oil storage tanks at the boiler house are discussed in the following subsection.

2.2 Storage Tanks and Transformers

Figure 2 shows the locations of historical site features such as storage tanks, leach fields, and transformers. These features are identified from a due diligence perspective with respect to potential releases from these features and the field sampling and analysis plan approach.

There were several large, above-ground bulk chemical storage tanks and structures, building-related storage tanks (both inside and outside buildings), underground fuel oil storage tanks, and five electrical transformers (potential for polychlorinated biphenyl [PCB] release) identified at the facility. The large above-ground storage tanks were located in the Plant B Tank Farm and the Plant D Tank Farm. The large urea silo was located between the Boiler House and Plant D. Figure 2 identifies above-ground tanks by number for ease of reference.

The Plant B Tank Farm included six large storage tanks identified on Figure 2 as Tanks 1 through 6 and also another tank identified as Tank 7. Those six tanks may have stored different raw materials over time, but they did contain, at a minimum, during some periods of time, diphenylamine, dioctyl phthalate (bis (2-ethylhexyl)phthalate), diisobutylene (trimethylpentene mixture), #415 Process Oil, nonylphenol, and formaldehyde (formalin), and they may have also stored other Plant B raw materials dimethylformamide, dinonylphenol, sodium nitrite, 2-ethylhexoic acid, and butanol, and Tank 7 stored ammonia (likely anhydrous). A 150,000 gallon water storage tank is located immediately south of the Plant B Tank Farm. This storage tank was constructed between 1956 and 1962.

The Plant D Tank Farm initially included four 10,000 gallon above-ground tanks (Tanks 20 -23) that contained chlorosulfonic acid, hydrazine, diphenyl oxide, and ammonium hydroxide to support production of Nitropore OBSC and OBSH. An additional tank identified as hydrazine storage was also present at a location between the plant D Tank Farm and the Plant D building. After Nitropore OBSH production had ceased, Plant D produced Nitropore 5 PT. That process required the liquids benzonitrile, sodium nitrite, dimethylformamide, and hydrochloric acid.

There were also several process-specific or building-specific storage tanks of various sizes as shown on Figure 2. These tanks included Tank 8 (formaldehyde) near plant B, Tank 9 (hydrazine day tank) and Tank 10 (caustic storage) at Plant C-3, Tank 11 (Wytox storage), Tank 12 (nonylphenol storage), Tank 13 (hydrazine day tank), Tank 14 (sodium chlorate storage), Tank 15 (sulfuric acid storage), and Tank 16 (sulfuric acid storage) at Plant C-1, Tank 17 (hydrochloric acid storage) and Tank 18 (sodium nitrite storage) at Plant A.

Three underground fuel storage tanks were located immediately to the east of the Boiler House. Two underground 12,600 gallon No. 6 fuel oil tanks and one underground 6,000 gallon No. 2 fuel oil tank stored fuel for the Boiler House. Wilmington Fire Department records document that two tanks were removed on July 11, 1986 (one 5,000 gallon tank and one 12,600 gallon tank). It appears the 5,000 gallon tank may have been the No. 2 fuel oil tank. Additional investigation activities will confirm the removal of the three USTs and investigate the soil quality in that area. The 1993 Phase II Field Investigation Report (Conestoga-Rovers & Associates, 1993) identifies a “removed fuel tank area” in the vicinity of the former Boiler House A that was located in or immediately adjacent to the General Purpose Building (Building 5 as shown on Figure 3). No documentation of the fuel tank in that area has been located.

Five electric transformers (identified as Transformer #1 through Transformer #5 on Figure 2) were identified at the facility. These transformers were located near the General purpose

Building, near the Plant B tank farm, to the east of the urea silo, adjacent to the East Warehouse, and at the south side of Plant D. These historical transformers represent a potential source of releases of PCBs.

A drum storage area was located to the west of Lake Poly. Drums were stored on this asphalt paved upland area.

2.3 Surface Waste Disposal Structures and Conveyances and Other Disposal Features

Several of the former manufacturing processes generated liquid wastes which contained sulfuric acid, sodium chloride, sodium sulfate, ammonium chloride, ammonium sulfate, chromium sulfate and other constituents. During the operation of the facility, there were four time frames with notable liquid waste disposal configurations.

- 1953 – 1958 liquid wastes to Lake Poly (Plants A, B, and C-1)
- 1958 – 1965 liquid wastes to Lake Poly and East and West Pits (Plants C-2 and C-3 added in 1962)
- 1965 – 1972 liquid wastes Lake Poly (through 1969) and Acid Pits (3) – Plant D added built 1968, operated 1969)
- 1972 – 1986 process liquid wastes to Pretreatment Plant (neutralization of acid), Lined Lagoons and MDC Sewer, Calcium Sulfate Landfill
    - MDC Sewer Connection 1972
    - Lined Lagoon I 1972
    - Lined Lagoon II 1973
    - Calcium Sulfate Landfill 1974

Between 1953 and approximately 1970, all liquid wastes generated at the facility were disposed of in unlined pits on the northern half of the property. These pits included Lake Poly, East and West Pits and the three Acid Pits (Figure 2). Table 1 shows the periods of operation of the liquid waste disposal features and the timeframes for the manufacture of each of the major products at the facility.

Lake Poly was an unlined surface impoundment approximately one-fifth of an acre in size located near the on-Property West Ditch. Smith reported that the liquid waste stream to Lake Poly included process wastes, cooling tower and boiler blow down waters, discharge from yard and floor drains, and the laboratory. Sodium dichromate was used in the Kempore® process and acidic wastes containing chromium were discharged to unlined pits until 1967. After 1967 sodium chromate was no longer used. Most of these wastes percolated through the porous soil underlying the pits and some wastes overflowed into the ditch system. From Lake Poly, overflows entered the On-Property West Ditch which flowed into the South Ditch which traverses the property from west to east and flows into the East Ditch. The East Ditch is a maintained railroad ditch that flows from north to south. Lake Poly was closed in 1969. Lake Poly has been the subject of several investigations and multiple soil removal actions as described in the 2007 Focused Remedial Investigation Report (MACTEC, 2007) and documented in several submittals to the MassDEP.

Prior to 1964, the West and East Pits also received the Kempore® process and acidic liquid wastes (Smith, 1977). These pits were filled in 1964 and 1965 respectively prior to construction of the West and East Warehouses. The three Acid Pits, located further to the south, replaced the East Pit and West Pit as waste disposal features in the 1964 – 1965 time frame and were used until their closure in 1971. The Acid Pits were three unlined pits located between the warehouses and the South Ditch. As shown on Figure 2, the west Acid Pit, the central Acid Pit, and most of the east Acid Pit are within the footprint of the slurry wall containment area. The slurry wall contains the on-property DAPL in the subsurface and there is a temporary cap in place to prevent direct contact with soils and to minimize infiltration of water into the containment structure. It is expected that the temporary cap will be replaced in the future with a permanent cap.

In approximately 1972, two lined lagoons and an acid treatment and neutralization system were added to the Olin Property to replace the unlined Acid Pits and Lake Poly. The lined lagoons received mainly acidic wastes that did not contain sodium dichromate wastes and were neutralized with lime. The acid treatment and neutralization system initially discharged to on-Property ditches. In approximately 1972 the system was connected to a municipal (Metropolitan District Commission or MDC) sewer. The acid neutralization in the lined lagoons resulted in precipitation of calcium sulfate (gypsum) and the lagoons were periodically dredged of this material. The gypsum dredge spoils were managed at the Calcium Sulfate Landfill. According to monitoring data from the late 1970s, the lined lagoons were leaking. Upon purchase of the property in 1980, Olin made several improvements to the facility. The lagoons were re-lined in approximately 1981 and 1983. The original liners were polyvinyl chloride (PVC) and replaced by Olin with 36 mil thickness hypalon liners. Leaks in process sewer lines were also repaired in approximately 1983 and 1984.

The former facility also contained buried drum areas and a buried debris area that predated Olin's ownership of the facility (Figure 1), but were discovered by Olin during 1980 maintenance activities (relining of Lagoon II) and post closure environmental assessments. Drum Area A consisted of drums and miscellaneous waste containing N-nitrosodiphenylamine (NNDPA), bis(2-ethylhexyl)phthalate (BEHP), trimethylpentenes, and chromium. Drum Area B consisted of drums, laboratory bottles, and miscellaneous wastes containing NNDPA, BEHP, phthalates, and chlorobenzenes. The buried drum areas also contained Opex® (dinitrosopenta-methylenetetramine) and Kempore® (azodicarbonamide). The Buried Debris Area contained materials similar to those disposed in Lake Poly (Smith, 1997). The remedial activities for the Drum and Debris areas were summarized in the 2001 Drum Removal Release Abatement Measure Status Report No. 2 and Completion Statement (GEI, 2001a) and the 2004 Part 2 Construction-Related Release Abatement Measure (RAM) Status Report No. 8 (GEI, 2004). Soils (4,350 cubic yards excavated, 200 cubic yards disposed), metal debris (54 tons), and 163 overpacks of old drums were excavated and shipped off-site for disposal. Confirmatory sampling of base and sidewalls of the excavations were conducted. The excavations were backfilled with suitable on-site borrow and excavated soil. Drum Area A and Drum Area B are located within the footprint of the current slurry wall containment area and associated temporary cap. No additional investigations of environmental media in these areas have been proposed here.

Central Pond. The Central Pond is a small feature located south of the manufacturing areas and immediately north of the South Ditch (Figure 1). No records of the construction or use of the Central Pond were available to MACTEC. The Central Pond sediments and shoreline soils have been the focus of removal actions that were conducted in 2000, 2001, 2003, and 2004. Sediments were removed to address chromium and phthalates and shoreline soils were removed to address oily soil. The remedial activities were summarized in the 2001 Status Report No. 2, Part 2 Construction-Related Release Abatement Measure (RAM) (GEI, 2001b) and the 2004 Part 2 Construction-Related Release Abatement Measure (RAM) Status Report No. 8 (GEI, 2004). The remedial actions included initial excavations of sediment and surface soil to a depth of up to 4 feet in Central Pond and the Central Pond Drainage Area (2,400 cubic yards), confirmatory sampling (68 samples), and subsequent additional excavation activities (to address residual chromium concentrations and observed oily soil on the bank). All of the organic sediments from central Pond were removed during these activities. The excavated sediment and soils were shipped off-property for disposal. The wetlands in the area were restored in May and June 2001. No additional investigation activities have been proposed for the environmental media in the area of this feature.

2.4 Sewer Systems

2.4.1 Early Sewer

In the early years of facility operations, process wastes from Plant A and Plant B were piped directly to Lake Poly. Beginning in 1957, process wastes were being piped to Lake Poly and the East and West Pits. In 1964, Lake Poly and the three acid pits were receiving piped process wastes and the East and West Pits had been closed. During some or all of this period, Plants A, B, and C were in operation.

2.4.2 Second Sewer System (August 1969)

An upgrade of the sewer system for the facility was completed on August 15, 1969 (Badger, 1969). Lake Poly was closed in 1969. Upon completion of this upgrade, there were three distinct sewer systems: sanitary sewer system; process sewer system; and the yard and floor drainage system. Figure 4 presents a schematic view of the sewer system as of 1970. This system operated as described below until the lined lagoons and pretreatment plant were constructed and the pretreatment plant was subsequently connected to the MDC sewer system in 1972.

<u>Sanitary Sewer</u>. The sanitary sewer conveyed sanitary sewage from various locations to septic tanks where solids removal occurred. The liquids from the septic tanks leached into the ground via conventional tile field systems. Septic tanks were located to the west of the General Purpose Building and to the east of Plant B. The septic tanks are discussed further in the following section.

<u>Process Sewer</u>. The process sewer was comprised of two components: the acid sewer; and the dilute waste system. The acid sewer was constructed with 4” – 6” Bondstream series 5000 epoxy and it conveyed concentrated acid waste from Plants C-1, C-3, and D to the acid pits located at the southeast portion of the facility. The dilute waste system was constructed of cast iron and clay piping and it conveyed all process wastes other than strong acids to the acid pits.

<u>Yard and Floor Drainage System</u>. Beginning in August 1969, the yard drainage and process area floor drainage was collected in trench drains and routed to a “sewer” that was installed in the area of the former Lake Poly. The “sewer” was also identified as an “oil basin” that could be used to remove light solid material from the yard drainage. Although some drawings show the concrete structure at this location as a “septic tank” there is no indication that sanitary wastes were

conveyed to this structure. The "sewer" discharged to the On-Property West Ditch that flowed to the South Ditch.

2.4.3 Third Configuration

The 1969 sewer upgrade was in place until 1970. In 1970, the wastewater neutralization system was constructed. In December 1971 the first lined lagoon replaced the three acid pits. During the closure of the acid pits in 1971 and the construction of the lined lagoon in 1971 and 1972, the treated waste water was discharged to the ditch system at the facility. In 1972, the process sewer system was connected to the MDC sewer system. At that point, the supernatant from the lagoon was discharged to the MDC sewer. The solids from the lined lagoon(s) were placed in the Calcium Sulfate Landfill beginning in January 1975.

In 1975, the sewer system for Plant A was abandoned and replaced. In 1981, the treatment effluent sewer line connecting the pretreatment plant to the MDC sewer was replaced.

Figure 5 shows the sewer system configuration as of 1983. The treatment system effluent was discharged to the MDC sewer system. As of 1983, the drawings still show yard drainage going to the "sewer" in the former Lake Poly area. The drawings do not specifically show any sanitary wastes lines going to the MDC sewer.

2.5 Septic Tanks/Systems

There is documentation of septic systems for sanitary wastes in two locations at the facility, as shown on Figure 2: to the west of the General Purpose Building (Building 4); and to the east of Plant B (Building 7). The septic tank cover west of the General Purpose Building remains in place. Figures 6 and 7 show the location of the septic tank and leach field at that location. The leach field for that septic system runs in a southeast to northwest direction from the septic tank cover as shown in the historical facility drawing. There is no visual surface evidence of a septic tank in the area of the former Plant B (Building 7). Figure 6 also shows the location of a tile field adjacent to Plant B.

Additional drawings from 1971 (Figure 8), 1982 (Figure 9), and 1983 (Figure 10) identify a concrete pit and open trench that is the point of discharge to the On-Property West Ditch or On-Property West Ditch wetland. Two of the drawings identify the concrete pit as a "septic tank". However, the drawings indicate that the structure drains subsurface lines that connect catch basins for the area to the west of the former Plant A and Plant C-1 and in the area between the warehouses and the former Plant C-1 (non-process yard drainage). There is no indication on these drawings that the concrete pit was connected by any subsurface pipeline to any buildings that may have generated sanitary waste or process waste streams. There is no current visual surface evidence of a septic tank or septic tank cover in the area shown on the three drawings. This feature is not a septic tank, but rather the "Lake Poly sewer" that was constructed in 1969 to receive non-process yard drainage and floor drainage.

In addition, there is a surface feature to the southeast of the 150,000 water storage tank that has the appearance of a concrete septic tank cover. Figure 11 is a photograph of that feature. This feature was not observed on any of the site drawings that have been reviewed to date. Inspection of this structure on July 17, 2008 indicated the structure is not a septic tank, but rather a cover for a junction box for underground electrical lines. There is also a manhole located to the east of this feature (Figure 12) that appears to be a manhole for the sewer line that runs to the north and connects to the sewer line at Eames Street.

REFERENCES

The Badger Company (Badger), August 21, 1969. Pollution Control Study for National Polychemicals Inc. at Wilmington, Massachusetts.

Conestoga-Rovers & Associates, June, 1993. Comprehensive Site Assessment, Phase II Field Investigation Report, Wilmington Facility, Wilmington, MA, Olin Corporation.

GEI, July, 2001a. Drum Removal Release Abatement Measure Status Report No. 2 and Completion Statement, Olin Property, Wilmington, MA, RTN 3-0471.

GEI, August, 2001b. Status Report No. 2, Part 2 Construction-Related Release Abatement Measure (RAM), Olin Wilmington Property, 51 Eames Street, Wilmington, MA, RTN 3-0471.

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MACTEC Engineering and Consulting, Inc. (MACTEC), October, 2007. Draft Focused Remedial Investigation Report, Olin Chemical Superfund Site, 51 Eames Street, Wilmington, Massachusetts.

Smith, June, 1997. Supplemental Phase II Report; Wilmington Massachusetts, Olin Corporation. MADEP RTN: 3-0471. Smith Technology Corporation, PTI Environmental Services; ABB Environmental Services, Inc. Geomega.

TABLES

Table 1. Chronology of Manufacturing and Waste Disposal Features
Olin Chemical Superfund Site
Wilmington, Massachusetts

Product	Plant	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Waste Disposal Features																																			
Lake Poly		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																	
East and West Pits						■	■	■	■	■	■	■	■																						
Acid Pits													■	■	■	■	■	■	■	■															
Lined lagoons																					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Pretreatment Plant																			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
MDC Sewer Connection																					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Calcium Sulfate Landfill																								■	■	■	■	■	■	■	■	■	■	■	■
Opex	A	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Kempore (with sodium dichromate)	C-1				■	■	■	■	■	■	■	■	■	■	■	■																			
Kempore (without sodium dichromate)	C-1																■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Resins	B									■	■	■	■	■	■	■																			
Phthalate plasticizers (dioctylphthalate dibutylphthalate)	B			■	■	■	■	■	■	■																									
Hydrazine	C-3											■	■	■	■	■	■	■	■																
Wytox 312	B													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Nitropore OBSH	D																		■	■	■	■	■	■											
Nitropore OT (4,4' oxybisbenzenedisulfonylhydrazide or OBSH)	D																	■	■	■	■	■	■	■											
Wiltrol-N (N-nitrosodiphenylamine)	B													■	■	■																			
Wytox ADP (dioctyldiphenylamine)	B										■	■	■	■	■	■	■	■	■	■															
Expandex 5 PT (5-phenyltetrazole)	Plant D-1/Pilot																		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			

TABLE 2
MAJOR PRODUCTS, RAW MATERIALS, AND WASTE MATERIALS AT 51 EAMES STREET FACILITY

Olin Chemical Superfund Site
Wilmington, Massachusetts

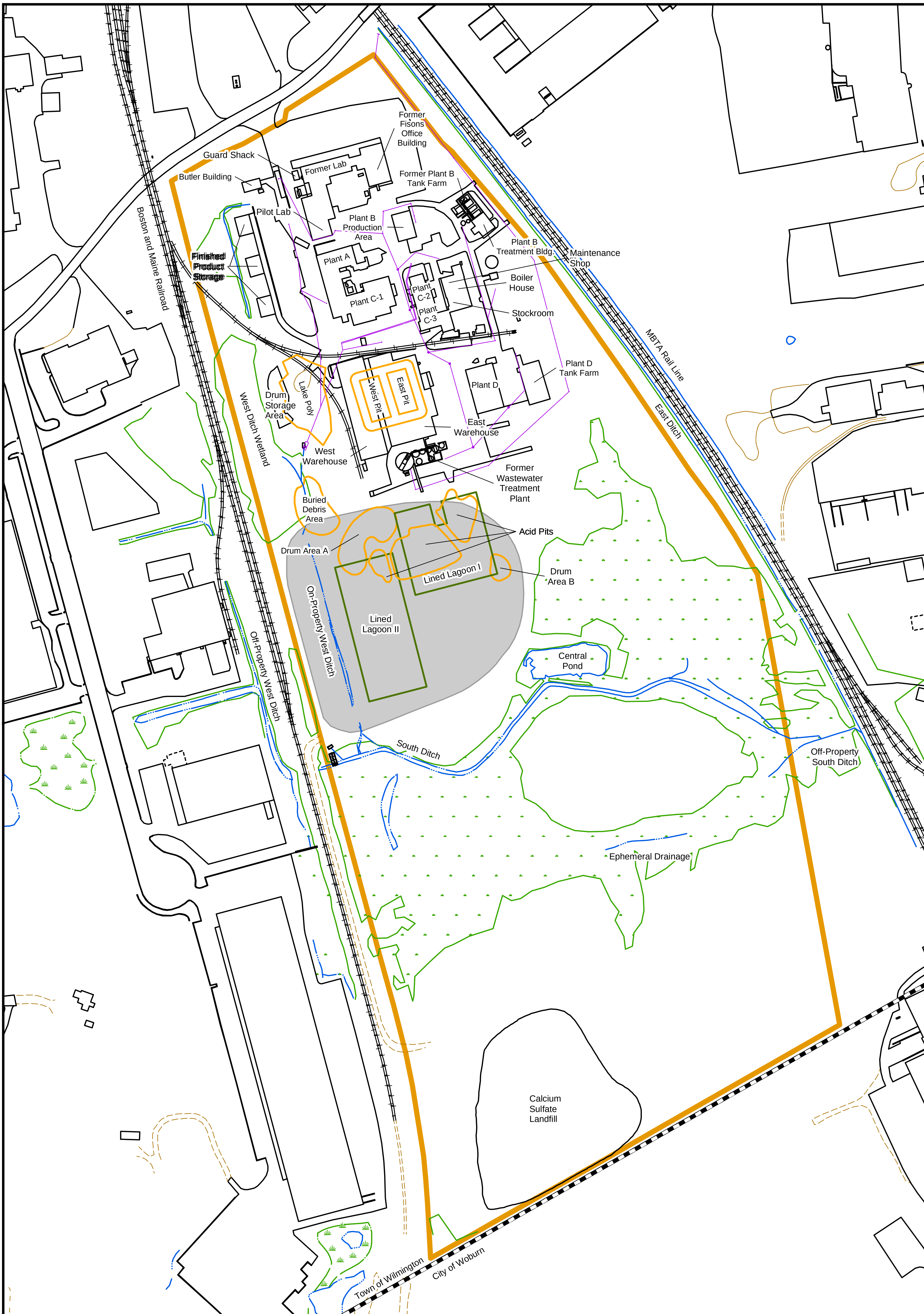
Product	Product Type	Chemical Name	Raw Materials	Notes	Waste Materials	Production Years	Plant	Waste Disposal Location
Opex	Nitrogen Blowing Agent	dinitrosopentamethylenetetramine	Hexamethylenetetramine Sodium nitrite Hydrochloric acid Processing oil Ammonia	liquid 30-33% hexamine (pH 9.5 - 11.5) clear yellow liquid, 40 - 45% NaNO2	Sodium chloride Sodium nitrate Formaldehyde Processing oil Ammonium chloride	1953 – 1986	Plant A	Lake Poly 1953 - 1969 Acid Pits 1970 - 1971 Wastewater Treatment Plant and MDC Sewer 1972 - 1986
Kempore	Nitrogen Blowing Agent	azodicarbonamide or azobisformamide	Hydrazine Urea Sulfuric acid Sodium chlorate Sodium Bromide (catalyst level) Sodium dichromate (1956 - 1967)	fuming water white liquid (64%) white prills, free-flowing white crystalline material white crystalline powder or granules	Sodium sulfate Sulfuric acid Urea Sodium chloride Ammonium sulfate Sodium bromide Chrome oxide (1956 - 1967)	1956 – 1986	Plant C-1 (reactor)	Lake Poly 1956 - 1957 East and West Pits 1958 -1965 Acid Pits 1966 -1971 Wastewater Treatment Plant and MDC Sewer 1972 - 1986
Kempore dispersions		Azodicarbonamide and dioctyl phthalate	Azodicarbonamide Dioctyl phthalate	solid liquid	None	1960 – at least 1980	Plant C until 1971 Plant B after 1971	
Hydrazine	Intermediate product for use in Kempore production	Hydrazine and semicarbazide solution	Urea Chlorine Sodium hydroxide Sulfuric acid	white prills, free-flowing	Sodium sulfate Sodium chloride Ammonium sulfate	1963 - 1970	Plant C-3	East and West Pits 1963 - 1965 Acid Pits 1966 -1970
Wytox ADP	Antioxidant/stabilizer	dioctyldiphenylamine	Diphenylamine Diisobutylene Aluminum chloride Sodium hydroxide	liquid	Aluminum hydroxide Sodium hydroxide	1962 - 1971	Plant B	Lake Poly 1961 - 1969 Acid Pits 1970 - 1971
Wytox 345/355/436 (polymeric phosphite)			Nonyl phenol Phosphorus trichloride Paraformaldehyde Oxalic Acid Additive W (from Plant B)	clear liquid clear liquid powder powder	HCl recovered by scrubber	1965 or 1966 (unconfirmed)	Plant C-1 extension	
OBSC/OBSH or Nitropore OT	Nitrogen Blowing Agent	4,4' oxybisbenzenesulfonylchloride(intermediate) or 4,4' oxybisbenzenesulfonylhydrazide	Diphenyl oxide Chlorosulfonic acid Hydrazine Ammonium hydroxide Oil	solid liquid liquid liquid	Chlorosulfonic acid Sulfuric acid Ammonium chloride Hydrochloric acid Sodium chlorosufonate	1970-1975	Plant D	Acid Pits 1970 - 1971 Wastewater Treatment Plant and MDC Sewer 1972 - 1975
Wiltrol-N	Retarder	N-nitrosodiphenylamine	Diphenylamine Sodium nitrite Sulfuric acid	clear yellow liquid, 40 - 45% NaNO2	Sodium nitrite Sodium sulfate	1965 - 1967	Plant B	Lake Poly 1965 - 1967
Wytox 312	Antioxidant/stabilizer	trisnonylphenyl phosphite	Nonyl phenol Phosphorous trichloride	clear liquid clear fuming liquid	None (HCl recovered by scrubber)	1965 – to at least 1980	Plant B	
Wytox Pap	Antioxidant/stabilizer	alkylated phenol	Nonyl phenol Dinonyl phenol Formaldehyde	clear liquid	None	1971 – to at least 1980	Plant B	
Actafoam R-3	blowing agent activator	Unknown (liquid azodicarbonamide activator)	2-ethylhexoic acid Zinc oxide Dioctyl phthalate	clear, colorless liquid	None	1963 – at least 1980	Plant B	
Nitropore 5PT	Nitrogen Blowing Agent	5-phenyltetrazole	Benzonitrile Sodium azide Sodium nitrite Ammonium chloride Dimethyl formamide Hydrochloric acid	clear oily liquid fine, white crystalline powder clear yellow liquid, 40 - 45% NaNO2 colorless liquid liquid	Sodium chloride Sodium nitrate Dimethyl formamide Benzonitrile	1973 – at least 1980 (limited quantities 12 tons per year)	"Pilot Plant" Plant D-1	Wastewater Treatment Plant and MDC Sewer 1973 - 1980
Phenolic and Urea Formaldehyde Resins		Phenolic and Urea Formaldehyde Resins	Phenol Urea Formaldehyde	liquid (50%)	Phenol Formaldehyde	1961 - 1967	Plant B	
Phthalate plasticizers		Dioctyl phthalate, dibutyl phthalate	Phthalic anhydride 2-ethylhexanol Butyl alcohol	white flakes colorless liquid liquid	None	1955 - 1961		Lake Poly 1955 - 1961

Table 3.
Buildings Associated with the 51 Eames Street Facility

Olin Chemical Superfund Site
Wilmington, Massachusetts

Building Number	Building Name	Function	Comment
1	Building #1	Finished Product Storage	
2	Building #2	Finished Product Storage	
3	Building #3	Finished Product Storage	
4	Office/Lab	Office/lab	
4A	Office Building	Office/lab	
5	General Purpose Building	Boiiler House "A", offices, pilot lab, electircal	
6	Plant A	Manufacturing	Opex, grinding
6A	Plant A extension	Ice house?	
7	Plant B	Manufacturing	Wytox ADP, Wytox PAP, PDA, PAP SE, R-10, Actafoam R-3
8	Plant C-1	Manufacturing	Kempore, grinding
8A	Plant C-1	Manufacturing	Phosphites
8B	Plant C-1 Shed (C-1 Extension)	Manufacturing	Kempore MC, FF, (Diosna) HS, N, F-2 powder
9	Plant C-2	Manufacturing	Kempore 60, 60/125, 150, AF, 200
9A	Plant C-3	Manufacturing	Hydrazine, Wytox Solids, RIA, Kempore Dispersions
10	Maintenance/Boiler Room	Maintenenace, heat, steam	
10A	Stock Room	Storage	
11	Pump House	Pump	
12	Butler Building	Storage	
13	No building with this number	NA	
14	Electrical Sub Station	Electrical	
15	West Warehouse	Storage	
15A	West Warehouse (south)	Storage	
16	East Warehouse	Storage	
17	Plant D (D-1, D-2, D-3)	Manufacturing	Nitropore OBSC/OBSH, Expandex 5PT
NA	Guard Shack	Security	
NA	Plant B Treatment Building	Groundwater containment/treatment	

FIGURES



Legend

Town Line	Structure
Drain/Sewer Line	Surface Water
Trail	Wetland Boundary
Paved Road	51 Eames St Property Boundary
Unpaved Road	Containment Structure (current feature, not historical)
Railroad	

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N

0 100 200 400 Feet

Figure 1
Historical Facility Features

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BJR 08/06/08 | Checked/Date: MJM 08/06/08

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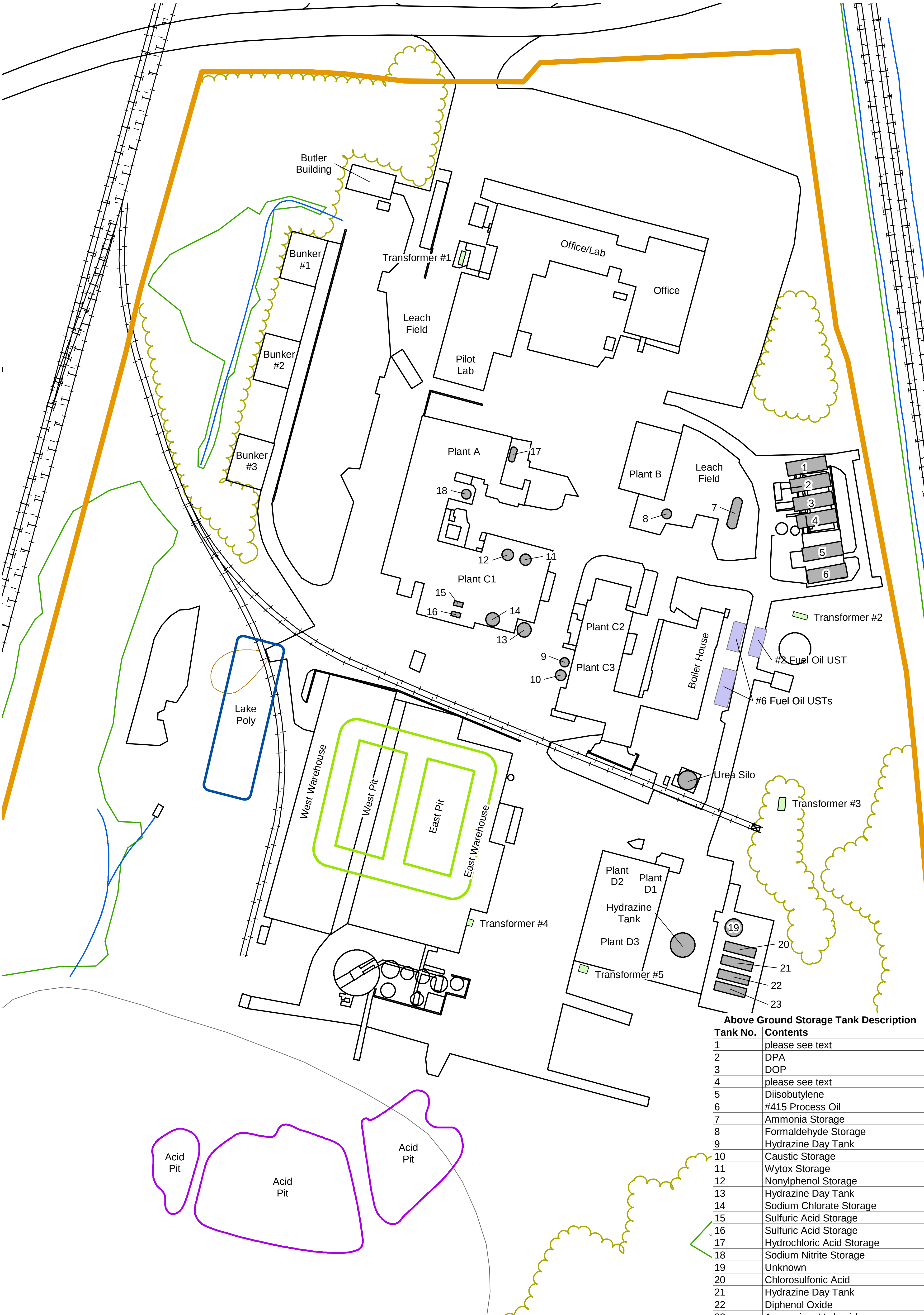

Above Ground Storage Tank Description

Tank No.	Contents
1	please see text
2	DPA
3	DOP
4	please see text
5	Diisobutylene
6	#415 Process Oil
7	Ammonia Storage
8	Formaldehyde Storage
9	Hydrazine Day Tank
10	Caustic Storage
11	Wytox Storage
12	Nonylphenol Storage
13	Hydrazine Day Tank
14	Sodium Chlorate Storage
15	Sulfuric Acid Storage
16	Sulfuric Acid Storage
17	Hydrochloric Acid Storage
18	Sodium Nitrite Storage
19	Unknown
20	Chlorosulfonic Acid
21	Hydrazine Day Tank
22	Diphenol Oxide
23	Ammonium Hydroxide

Legend

- Above Ground Storage Tank
- Underground Storage Tank
- Transformer
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Sidewalks
- Structures
- Surface Water
- Trails
- Wetland Boundary
- Wooded Areas
- Culvert

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N

0 40 80 160
Feet

Figure 2
Facility Storage Tanks, Leach Fields, and Transformers

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BJR 10/15/08 | Checked/Date: MJM 10/15/08

Document: P:\OLIN\Wilmington\GIS\MapDocuments\RI Work Plan\Olin_11X17_P_rotated.mxd PDF: P:\OLIN\Wilmington\2007 Remedial Investigation Work Plan\Field Sampling Plan\APPENDIX A SiteBackgroundandFeatures\Figures\Figure 2 - Facility Storage Tanks, Leach Fields, and Transformers.pdf 10/15/2008 9:10 AM bjroden

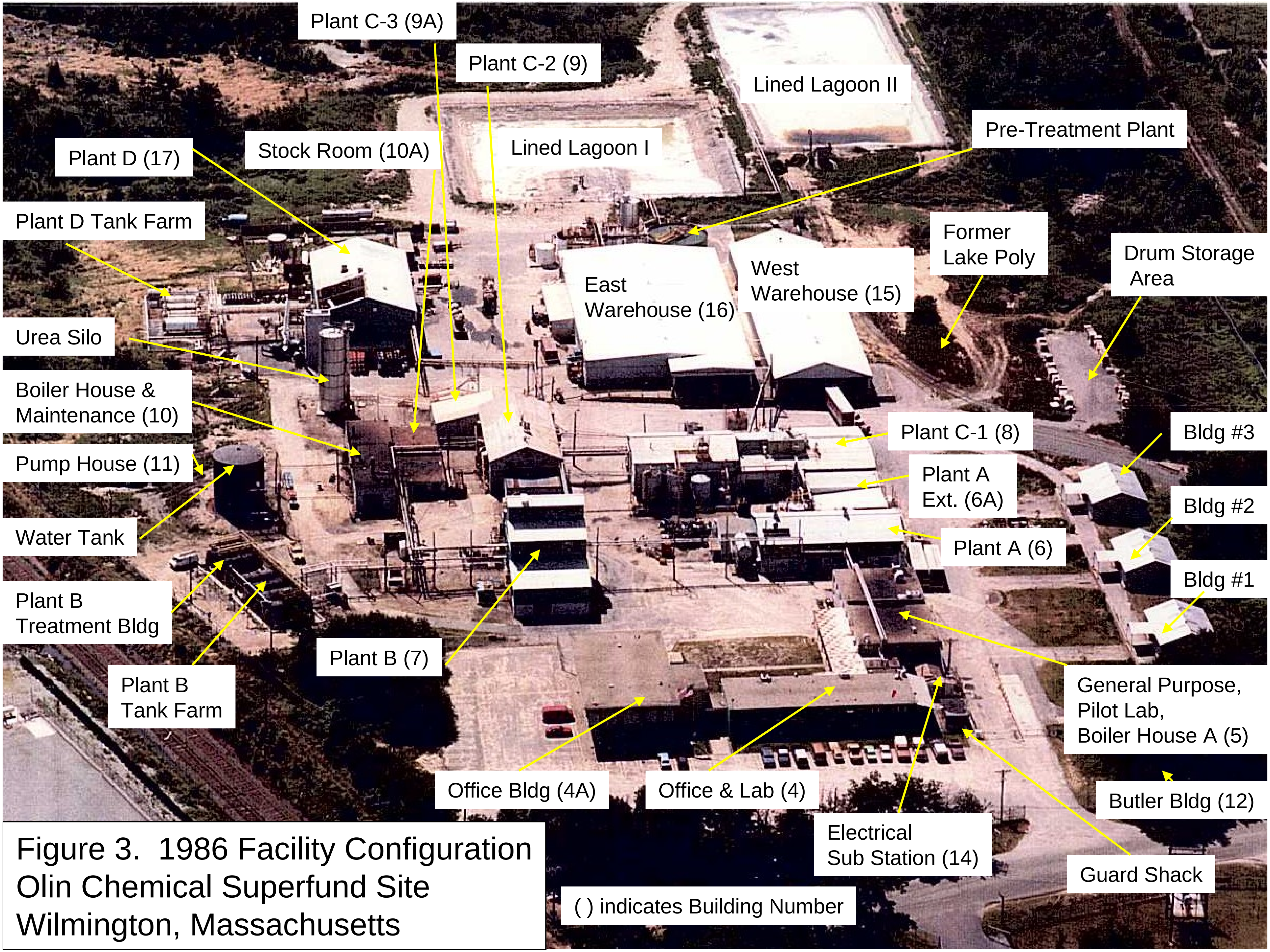
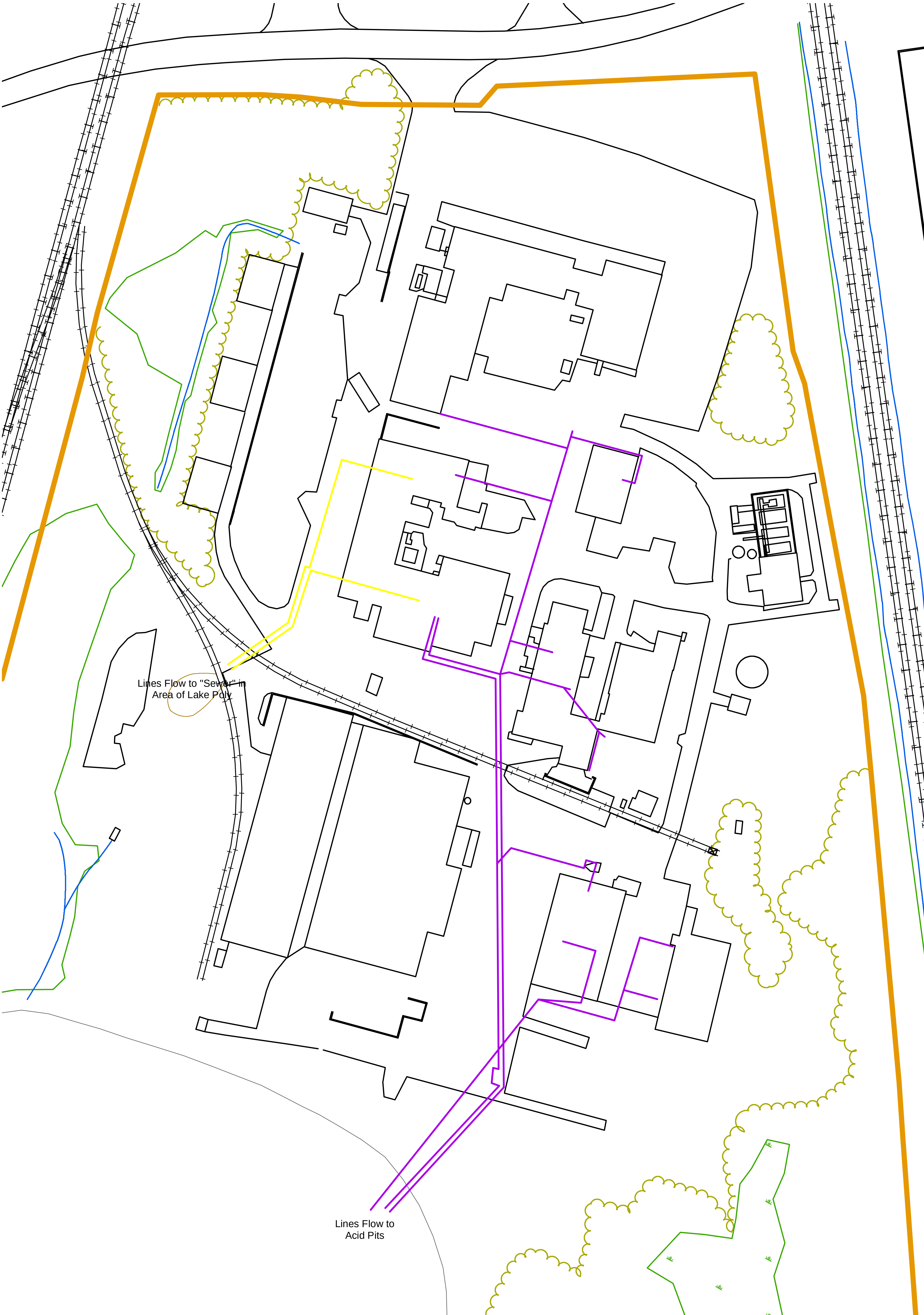


Figure 3. 1986 Facility Configuration
Olin Chemical Superfund Site
Wilmington, Massachusetts



Legend

- Process Sewer (acid sewer and dilute)
- Yard and Process Floor Drainage
- 51 Eames St. Property Boundary
- Paved Road
- Unpaved Road
- Sidewalks
- Structure
- Surface Water
- Trails
- Wetland Boundary
- Wooded Areas
- Culvert

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N

0 40 80 160
Feet

Figure 4
Sewer Lines
1970

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BJR 07/08/08 | Checked/Date: MJM 07/08/08

Document: P:\OLIN\Wilmington\GIS\MapDocuments\RI Work Plan\Olin_11X17_P_rotated.mxd PDF: P:\OLIN\Wilmington\2007 Remedial Investigation Work Plan\Field Sampling Plan\SiteBackgroundandFeatures\Figure 4 - Sewer Lines 1970.pdf 07/08/2008 4:18 PM bjroden

Legend

- Non Process Sewer
- Process Sewer
- Non Process Trench
- Process Trench
- Catch Basin Location
- Manhole Location
- Manhole Location (Fiber Glass)
- Septic Tank Cover
- 51 Eames St. Property Boundary
- Water
- Railroad
- Paved Road
- Unpaved Road
- Wetland Boundary

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N

0 40 80 Feet

Figure 5
Sewer Lines as of July 1983

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BJR 07/08/08	Checked/Date: MJM 07/08/08

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Green box indicates leach field near general purpose building.

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Figure 6
1957 Underground Pipe Layout

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared/Date: BJR 10/14/08	Checked/Date: MJM 10/14/08

Green box indicates leach field near general purpose building.

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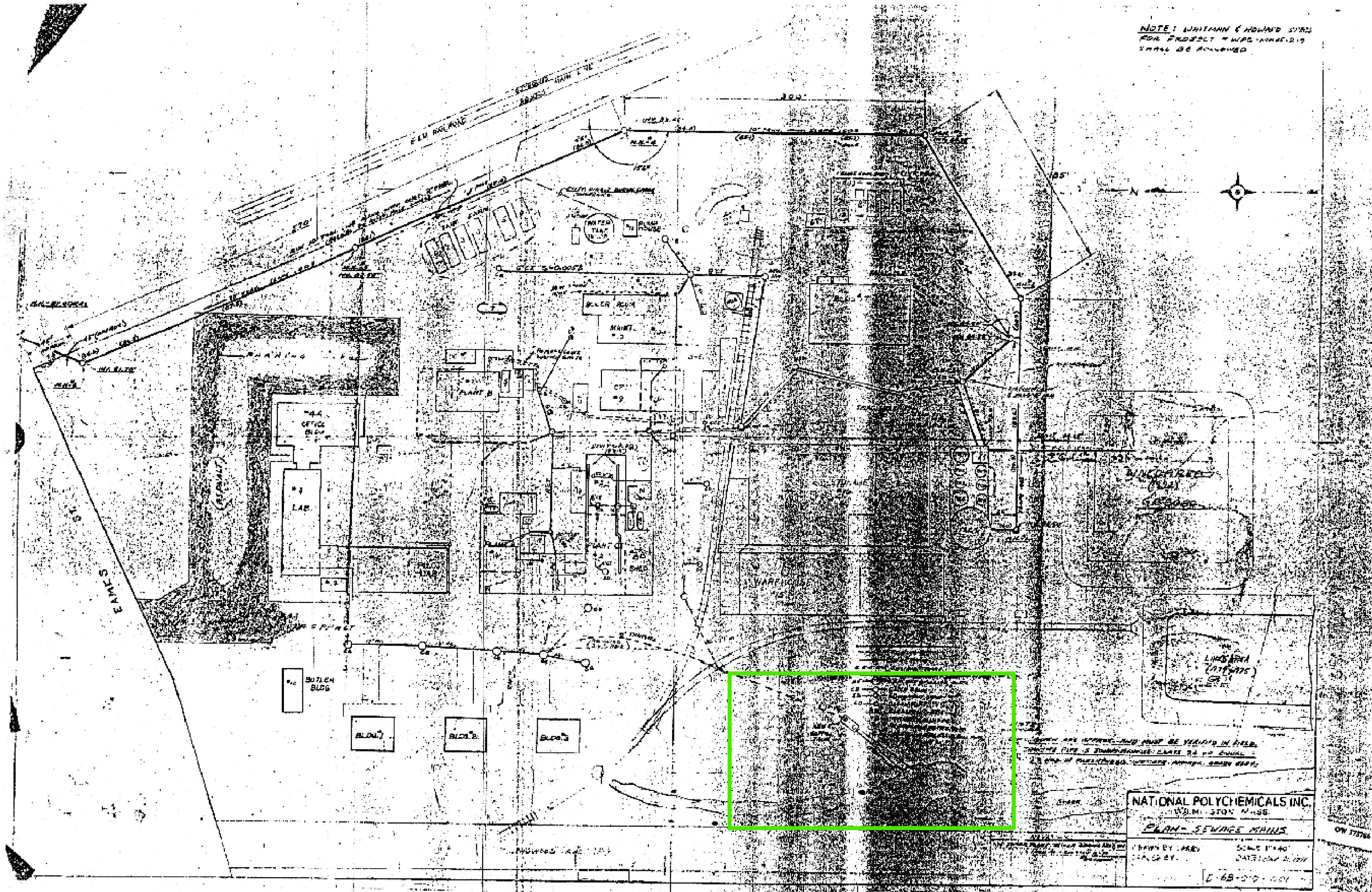
Figure 7
Modifications to Sewerage System

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared by BJR | Checked by MJM

Document: P:\OLIN\Wilmington\GIS\MapDocuments\RI Work Plan\Appendix A Scanned Figures 11X17LS.mxd PDF: P:\OLIN\Wilmington\2007 Remedial Investigation Work Plan\Field Sampling Plan\APPENDIX A SiteBackgroundandFeatures\Figures\Figure 7 - Modifications to Sewerage System.pdf 10/14/2008 4:50 PM bjroden



Green box indicates concrete pit and open trench that is the point
of discharge to the On-Property West Ditch or On-Property West Ditch wetland

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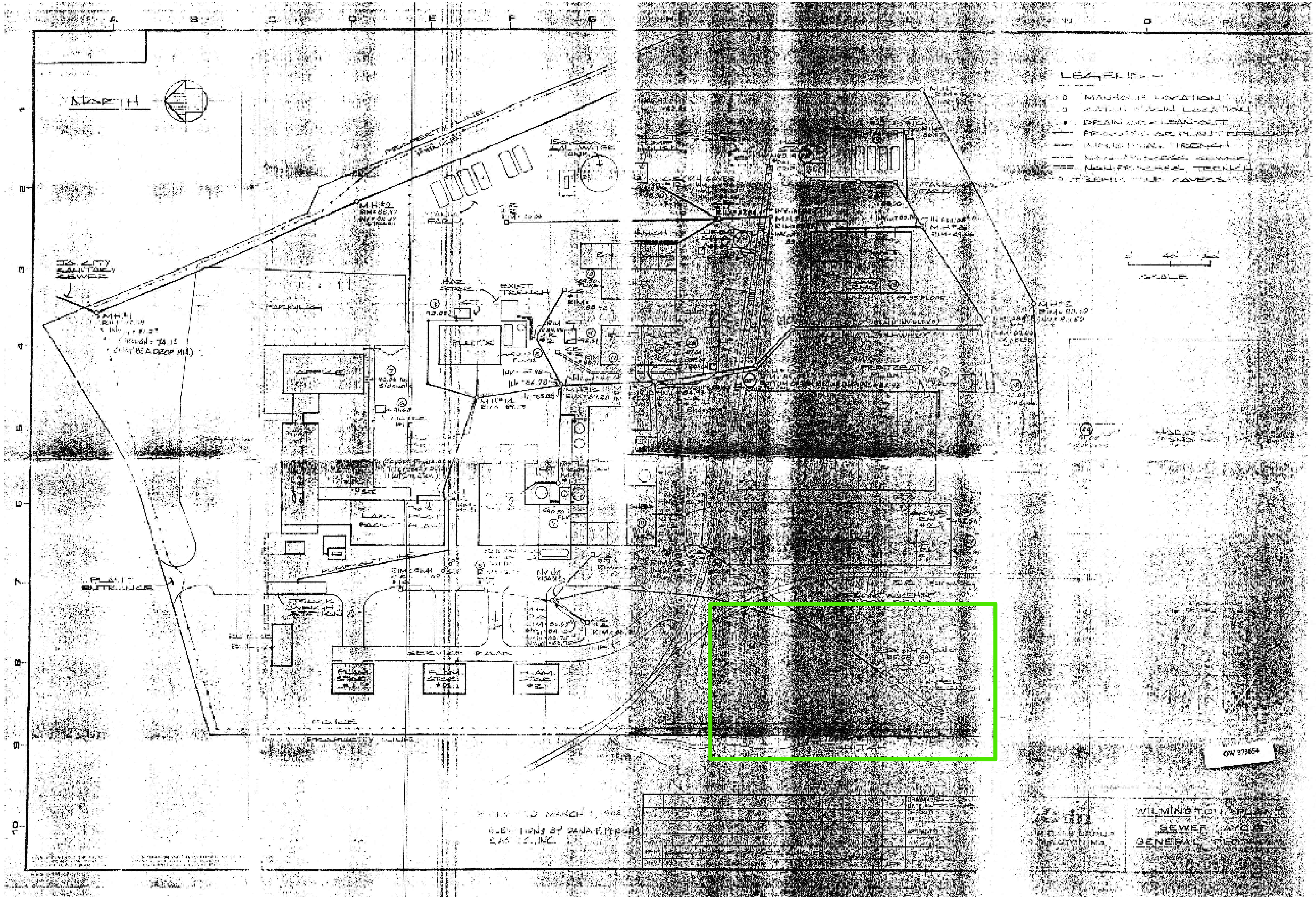
Figure 8
1971 Plant Sewage Mains

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared by BJR	Checked by MJM



Green box indicates concrete pit and open trench that is the point
of discharge to the On-Property West Ditch or On-Property West Ditch wetland

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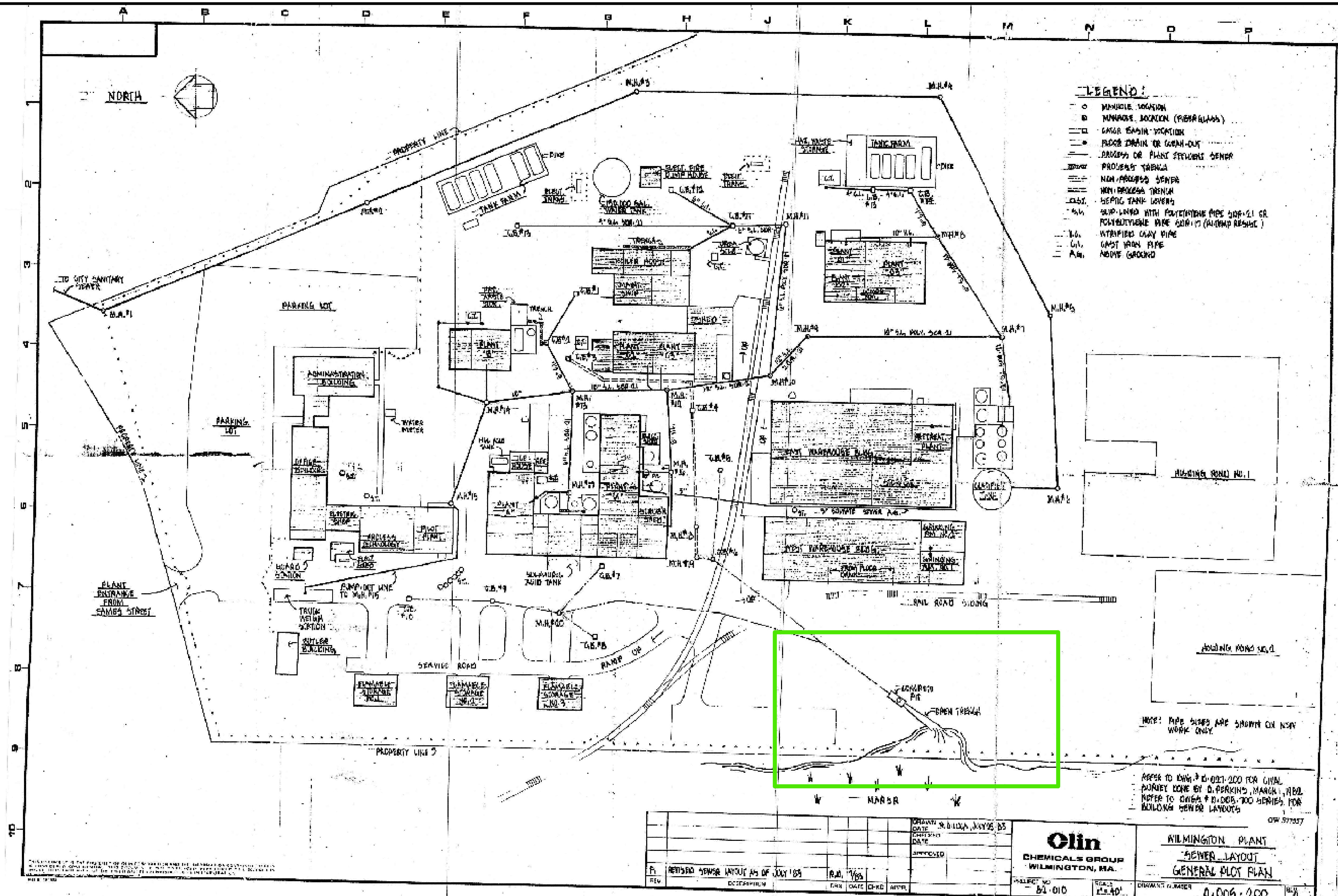
Figure 9
1982 Sewer Drawing

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared by BJR	Checked by MJM



Green box indicates concrete pit and open trench that is the point
of discharge to the On-Property West Ditch or On-Property West Ditch wetland

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Figure 10
1983 Sewer Layout

Olin Chemical Superfund Site
Wilmington, Massachusetts

Prepared by BJR	Checked by MJM

Olin Chemical Superfund Site Wilmington, Massachusetts	MACTEC	Figure 11 Concrete Cover Southeast of Water Tank

Olin Chemical Superfund Site
Wilmington, Massachusetts

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Figure 12
Manhole Southwest of
Water Tank

APPENDIX B

Standard Operating Procedures

SOP No. S-1

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

LOW-FLOW/LOW-STRESS GROUNDWATER SAMPLING

STANDARD OPERATING PROCEDURE

LOW-FLOW/LOW-STRESS GROUNDWATER SAMPLING

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes methodologies for low- flow/low-stress groundwater sampling and calibration of the field instruments utilized. This procedure includes the minimum required steps and quality checks that employees and subcontractors are to follow when sampling groundwater using this technique. This SOP addresses technical requirements and required documentation to be completed during low-flow groundwater sampling and equipment calibration.

MACTEC Engineering and Consulting, Inc. follows the EPA Region I Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, Revision 2, July 30, 1996 (Attachment 1).

2.0 SUMMARY OF METHOD

This method of groundwater sample collection involves minimal disturbance of the groundwater aquifer to obtain a "representative" sample of groundwater. The method requires pumping of groundwater at a slow rate to minimally influence the water level, all the while monitoring groundwater quality parameters including dissolved oxygen, redox potential, conductivity/specific conductance, temperature, pH, and turbidity. These parameters will dictate the point at which the aquifer water entering the well is considered representative of the ambient groundwater surrounding the well.

3.0 DEFINITIONS

Not applicable.

4.0 HEALTH AND SAFETY WARNINGS

Collecting groundwater samples using this method is not particularly hazardous physically. Care should be taken to minimize slip/trip/fall hazards due to the presence of a large amount of equipment in a fairly small area. Additionally, sample preservatives commonly include strong acids and bases. Care should be taken to prevent human contact with the acids and bases, and in addition, particular care should be taken to store each separate from the other. For chemical hazards, the monitoring well to be sampled should have a headspace reading collected from it immediately upon opening the well riser. Refer to the site safety plan for details regarding action levels and response actions.

5.0 CAUTIONS

See section 4.0.

6.0 INTERFERENCES

Minimizing turbidity in the sample is the core reason for utilizing this method of sampling. If turbidity is encountered in excessive amounts, the analytical results can be skewed to the higher end, and not provide a "representative" groundwater sample.

7.0 PERSONNEL QUALIFICATIONS

The sample collection personnel should be familiar with the sample collection method as well as being familiar with the particular pumps to be used. Familiarity with the pumping system will allow the field personnel to troubleshoot a problem more efficiently.

8.0 EQUIPMENT AND SUPPLIES

- Pump (bladder pumps and centrifugal pumps are preferred) constructed of stainless-steel. Peristaltic pumps may be utilized with caution
- Tubing, (Teflon or Teflon lined is preferred); however polyethylene tubing and silicone tubing may also be used
- Water level meter
- 0.45µm cellulose-based membrane filter for dissolved sample fraction collection
- Power source (generator, compressed gas)
- Flow-through cell with multi-probes
- Decontamination supplies
- Field Logbook
- Field Data Records
- Timer (watch)
- Sample bottles
- Labels
- Preservatives
- Well keys
- PID/FID

9.0 PROCEDURES

9.1 Equipment Calibration

- Equipment including the flow-through cell and water quality probes, turbidity meter, and pump flow (as necessary) will be calibrated as per the manufacturer's specifications. Manufacturer's literature for each piece of equipment will be included in planning documents and will be made available to the field staff. A field instrument calibration Field Data Record (see Appendix B of the Field Sampling Plan) will be completed to document instrument calibration checks.

9.2 Sample Collection

- Record condition of the well at the surface.
- Remove the well cap and immediately record monitoring well headspace using a calibrated PID/FID.
- Measure and record the initial depth to water.
- Install the pump in such a manner so as not to disturb the well. The intake should be set at the midpoint of the interval to be sampled.
- Connect all tubing such that the flow-through cell is connected in-line with the sample system.
- Start the purge of the well using the lowest setting on the pump, and gradually increase the speed until discharge occurs. Recheck the water level to verify that not more than 0.3 feet of head change is noted. Attaining this criterion is not always possible particularly in tight formations. If excessive drawdown occurs, record water level measurements and compare discharge and drawdown to well storage to determine inflow volume of water through well screen.
- Continue purging until monitoring parameters stabilize. Readings should be taken at least every five minutes. Stabilization is considered to be achieved after three consecutive readings are within the following limits:

    - <u>Turbidity</u> - +/- 10% for values greater than 10 NTU; if turbidity is greater than 10 and well is not stable, continue purging well for up to two hours, collect sample and document on field data record and in log book (collection of a filtered sample for metals analysis may be necessary if turbidity is greater than 25 NTU).
    - <u>Dissolved Oxygen</u> - +/- 10%
    - <u>Specific Conductance</u> - +/- 3%
    - <u>Temperature</u> - +/- 3%
    - <u>PH</u> - +/- 0.2 standard units
    - <u>ORP</u> - +/- 10 mV

- After the monitoring parameters have stabilized according to the above criteria, the sample may be collected by removing the in-flow tubing from the flow-through cell and inserting it into the sample container. Do not turn the pump off at any point during the purging or sample collection procedures. Otherwise, reinitializing the system may require additional stabilization time.
- If turbidity value of final parameter measurement is greater than 25 NTU, an additional filtered fraction may be collected for metals analysis using a 0.45μm cellulose-based membrane filter. A filtered fraction for metals may also be collected if specified in the Field Sampling Plan.
- After the sample has been collected, remove the pump from the well and disconnect all tubing and other connections.
- The tubing may be dedicated to the well or disposed of.
- The pump (excluding peristaltic pumps) must be decontaminated prior to use in a subsequent well. New bladders in bladder pumps must be installed (after the unit has been decontaminated). The decontamination procedure is as follows:

  - Flush the unit with portable water
  - Flush the unit with a non-phosphate detergent solution
  - Flush the unit with distilled/deionized water
  - Flush the unit with methanol. This step may be skipped if previous blank samples show no or insignificant levels of organic contamination
  - Flush the unite with distilled/deionized water

10.0 DATA AND RECORDS MANAGEMENT

Field data should be recorded on the Low Flow Groundwater Sampling Field Data Record (See Appendix C of the Field Sampling Plan). These reports along with any analytical data will be provided in some form or investigation or completion report.

11.0 QUALITY CONTROL/QUALITY ASSURANCE

Quality control for this groundwater sampling method involves the collection of field quality control samples including field duplicated, matrix spike/matrix spike duplicate samples, trip blank samples, equipment blank samples, and temperature blank samples. Frequency of collection or QC samples will be specified in the Field Sampling Plan.

12.0 REFERENCES

United States Environmental Protection Agency (USEPA), July 30, 1996. EPA Region I Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, Revision 2.

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

July 30, 1996
Revision 2

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Use of trademark names does not imply endorsement by U.S.EPA but is intended only to assist in identification of a specific type of device.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permealability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or

Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

turbidity (10% for values greater than 1 NTU),
DO (10%),
specific conductance (3%),
temperature (3%),
pH (± 0.1 unit),
ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII. FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

EXAMPLE (Minimum Requirements)

Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)______________________
Well Number______________ Date______________
Field Personnel______________________
Sampling Organization______________________
Identify MP______________________

Depth to (below MP) ________/________ of screen (top / bottom)
Pump Intake at (ft. below MP)______________
Purging Device; (pump type)______________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP/ Eh[3] mv	DO mg/L	Turb-idity NTU	Comments

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25 °C.
3. Oxidation reduction potential (stand in for Eh).

SOP No. S-2

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

SURFACE WATER AND SEDIMENT SAMPLING

STANDARD OPERATING PROCEDURE

SURFACE WATER AND SEDIMENT SAMPLING

1.0 SCOPE AND APPLICABILITY

To establish clear, uniform procedures for surface water and sediment sampling that will ensure consistency and quality of samples.

This procedure applies to all surface water and sediment sampling activities. It assumes that sample locations have been identified in a project planning document (Field Sampling Plan [FSP] and Work Plan) and that sampling locations have been previously identified, with flagging or some other appropriate field marker, based on the investigation data collection objectives.

2.0 SUMMARY OF METHOD

A surface water and sediment Field Data Record (FDR) (see FSP Appendix B) must be completed for each sampling location. A working knowledge of the sampling equipment to be used is a basic requirement for understanding surface water and sediment sampling procedures.

Familiarity with the U.S. Environmental Protection Agency (USEPA) sediment sampling guidelines (USEPA, 2004) and the project FSP and Work Plan objectives is required. The Field Operations Leader and the field samplers should review the appropriate FSP sections to verify project objectives prior to sample collection.

Familiarity with the site-specific health and safety plan (HASP) is required prior to conducting surface water and sediment sampling procedures.

3.0 EQUIPMENT AND SUPPLIES

Equipment requirements and specifications for surface water and sediment sampling are as follows.

<u>For Surface Water:</u>

Any equipment used to collect surface water samples is acceptable as long as it does not violate the integrity of the sample and it provides a representative surface water sample. Actual site-specific conditions and the physical sample location will determine the appropriate equipment required for sample collection. The following list includes several types of equipment typically used for the collection of surface water samples:

- waders (chest-high or waist-high)
- a small boat, raft, or canoe
- glass beakers or sample bottles
- glass or stainless-steel (SS) bucket
- temperature, specific conductivity, and pH meter
- personal protective equipment (PPE) as specified in the site-specific HASP
- appropriate sample containers (from a certified lab) w/ labels and a preservation kit with the appropriate preservatives
- hard cover field log book, indelible pen, coolers, ice in sealable plastic bags, wide transparent tape, reinforced strapping tape, and chain-of-custody (COC) forms and seals;
- dissolved oxygen (DO) meter
- filtration kits
- Surface Water and Sediment FDR (See FSP Appendix B)

<u>For Sediment:</u>

Any equipment used to collect sediment samples is acceptable as long as it does not violate the integrity of the sample and it provides a representative sediment sample.

Actual site-specific conditions and the physical sample location will determine the appropriate equipment required for sample collection. The following list includes several types of equipment typically used for the collection of sediment samples appropriate for the Olin Site:

- SS Shelby or similar push tubes;
- SS spoons, scoops, or trowels;

- SS or S hand augers with extensions;
- glass/pyrex mixing bowls;
- PPE as specified in the site-specific HASP;
- appropriate sample containers (from a certified lab) with labels; and a preservation kit with the appropriate preservatives;
- hard cover field log book, indelible pen, coolers, ice in sealable plastic bags, wide transparent tape, reinforced strapping tape, and chain of custody papers and seals; and,
- Surface Water and Sediment FDR (See FSP Appendix B).

4.0 PROCEDURE FOR SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples are occasionally taken at the same time to help define the partitioning of contamination between water and sediment. If both water and sediment are to be collected at a given sample point, the water sample should be collected first. Sample locations are often determined in the field at the time of sampling and should be noted in the field log book.

All sampling equipment must be decontaminated prior to sample collection. During prolonged field events, a designated decontamination area should be set up on site to facilitate repetitive decontamination as required.

During sediment sampling the field sampler will take time to allow all surface water to run off the sampling device and sample prior to preparing laboratory samples. This will be done to reduce the water content of the sediment sample prior to homogenization and preparation of samples.

4.1 Surface Water Sampling

The physical location of the sample and site conditions will dictate the type of sampling equipment selected. Several common sampling methods and the corresponding equipment to be used are presented as follows. The appropriate method will be specified in the site-specific sampling and analysis plan (SAP).

<u>Direct Dipping Method</u>

Because of simplicity, when sampling surface water, direct dipping of the sample container into the surface water body is desirable. Steps to follow in using the direct dipping method include:

1. Acquire a small boat or waders. If wading is required always approach the sample location from downstream. Wading may cause bottom deposits to rise and bias the sample and is acceptable only if a current is noticeable.
2. Arrange sample containers in the preferred order of sampling (see Attachment I).
3. Using a small beaker or the sample port of the pH/specific conductivity meter, collect a small water sample and record the temperature, pH, and specific conductivity readings in the field log book.
4. Dip containers such that the top or opening is pointed upstream allowing the sample to be collected directly into the container.
5. Take special care to avoid completely submersing pre-preserved sample containers so that these chemical are not lost and released into the water.
6. Repeat as necessary filling all required sample containers.
7. Preserve sample containers as necessary.
8. As the sample containers are filled place them in a cooler supplied with ice for packing and shipment.
9. Secure all containers in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.
10. Complete all required COC and analysis request forms and release samples for shipment.

4.2 Sediment Sampling

Prior to sample collection, all sampling locations should be tested for the presence of quality sediment deposits, and the selected sampling locations should be marked prior to the sampling event. The exact location where the sediment media is obtained will be based on the judgment of the sampler. Samples should not be collected from river bed sands or scoured out bottom areas that are subject to change with current flows. Sediments should be collected from depositional areas where fine grain silts have accumulated. A sediment sample should not contain standing water or other extraneous material (twigs, leaves, stones). The sampler should take detailed notes on each location and include a description of the physical appearance of the sediment.

The physical nature of the sample collection location may dictate the type of equipment used. The following outlines several sampling methods and the corresponding equipment to be used. A project specific method may be specified in the site-specific FSP. During sediment sampling the field sampler will take time to allow all surface water to run off the sampling device and sample prior to preparing laboratory samples. This will be done to reduce the water content of the sediment sample prior to homogenization and preparation of samples.

Shovel – Hand Held Trowel

The field sampler will identify the best area available to obtain depositional sediment media. The sampling device will be slowly advanced into the sediment and slowly raised above the water surface to obtain a contiguous segment of the sediment media. Remove the sampling devise and sediment sample from the water and allow water to run off the sample. Transfer the sediment to the mixing bowl trying to avoid adding any surface water to the sample.

If sediment samples are scheduled for volatile organic compounds (VOC) analysis, this parameter will be collected first. For off-site VOC soils, both low concentration samples and methanol preserved samples will be collected as described in Method 5035. Low concentration samples will be collected (with 5 grams of sample) in vials containing stirrer bars and sodium bisulfate. High concentration samples are collected (with 10 grams of sample) in vials preserved with methanol. Off-site VOC samples will consist of two vials for low concentration analysis and one vial (methanol preserved) for high concentration analysis. The soil sample will be transferred to the vial using a plastic syringe designed to reduce the exposure of the soil sample to air. The syringe will be advanced directly into the sediment in the stainless steel bowl. An addition soil jar will be collected for percent solids determination to be used only for the VOC sample. The jar should be labeled "VOC percent solid" with the same sample information as the original sample. If a field duplicate sample is scheduled at the location, the sampler will first remove the VOC sample segments for both the field sample and duplicate sample using the procedure described above.

After the VOC sample has been collected (if required by work plan), the soil within the stainless steel bowl will be homogenized (mixed) with a stainless steel spoon so that each sample aliquot is representative of the whole. Care should be taken to ensure that sufficient soil is present in the stainless steel bowl to fill all of the associated sample fractions (containers) and duplicate fractions, if necessary. The sample will be allowed to settle for five minutes. Decant as much standing water as possible taking care not to loose any fine solids. The sampler will prepare the analytical sample fractions (e.g., semi-volatile organic compounds [SVOCs], pesticide/polychlorinated biphenyls [PCBs], and inorganics) using a stainless steel spoon to transfer the soil into the sample containers.

Direct Push Core or Augers

Shelby tubes and most other push tubes commonly use Teflon™, Lucite™, or polyethylene liners in various lengths (1 to 3 feet) and diameters (2 to 4 inches). They can be used together or as a stand alone sampling device. Other sampling equipment includes hand driven split spoon samplers and soil augers with an extension handle.

1. Acquire a small boat or waders. If wading is required always approach the sample location from downstream. Wading may cause bottom deposits to rise and bias the sample and is acceptable only if a current is noticeable, or if boat access is not possible.
2. Arrange sample containers in the preferred order of sampling (see Attachment I).
3. Place corer tube assembly, or split spoon sampler, or auger head in proper location and drive or auger to desired depth in the sediment using steady hand pressure.
4. Work the tube or device to loosen the sample by twisting, if possible, to shear off the sediment at the base.
5. Carefully pull the tube or device upward and immediately cap the bottom or contain the bottom to prevent loss of sample. If using a sampling tube, or a tube and liner, a Teflon-lined cap should be used to seal the bottom.
6. If using a Shelby or direct push tube, wipe off the tube walls and rinse with mild Liquinox detergent or similar to remove excess sediment sticking on the tube. If using a split spoon samplers or auger device, transfer sample to a clean SS bowl, obtain samples for VOC analysis (if required) as previously described, homogenize and then transfer remaining sample aliquots to appropriate sample containers as required.
7. Drain off any excess standing water in the sample tube or sample bottles.
8. Cap the top of the tube with a Teflon-lined cap and tape both ends of the tube as necessary.
9. Label the tube or sample bottles with the proper sample ID, site, length of sample, date, and time.
10. Place the tube or sample bottles in a cooler supplied with ice for packing and shipping.
11. Repeat Steps 3 through 10 for all required analyses.

12. Secure all containers in coolers with adequate bubble wrap and ice so as to maintain a temperature of 4°C during shipment.
13. Complete all required COC and analysis request forms and release samples for shipment.

5.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), September, 1998. "Region 1, EPA New England Sediment Sampling Guidance"; Quality Assurance Unit Staff; Office of Environmental Measurement and Evaluation.

SOP No. S-3

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

SURFACE SOIL SAMPLING

STANDARD OPERATING PROCEDURE

SURFACE SOIL SAMPLING

1.0 SCOPE AND APPLICABILITY

The purpose of this Standard Operating Procedure (SOP) is to describe the methods used for obtaining surface soil samples for physical or chemical analysis. Collection of soil samples for laboratory analysis for volatile organic compounds may require specially prepared containers, syringes, or Encore samplers. This SOP also describes the procedures for using the various types of sampling equipment, which include shovels, trowels, and hand-augers. The equipment may be constructed of special materials (for example, stainless steel, inert plastics) according to specific project requirements.

2.0 RESPONSIBILITIES

The field sampling personnel will be responsible for the proper use and maintenance of all types of equipment used for obtaining surface soil samples, and the collection, labeling, handling and storage of all samples until further chain of custody procedures are undertaken.

3.0 EQUIPMENT AND SUPPLIES

3.1 Shovel - Long or Short Handle Type

Used for penetrating the upper surface and/or obtaining soil samples directly. Shovel blade must not be painted when obtaining samples for metals analysis.

3.2 Trowel - Basic Garden Variety, which Resembles a Small Shovel

Constructed of steel or polypropylene (plastic). The blade of a trowel is generally flat and 5 to 6 inches in length. A scoop (blade has curved edges versus flat) may be substituted if necessary.[1] The trowel blade must not be painted when sampling for metals analysis.

3.3 Hand Augers

These tools are generally comprised of a short, hollow, thin-walled augers connected to a "T" shaped handle. Clockwise rotation of the T-handle with moderate downward pressure

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[1] Requirements for inert materials, decontamination, or calibrated sampling tools may be required depending upon the purpose of the sampling. These requirements will be detailed in a project-specific sampling plan.

initiates the cutting and soil sampling process. Some augers are designed to accommodate an optional, plastic or metal, cylindrical sample sleeve which can be inserted into the body of the auger to facilitate sample collection and to avoid cross-contamination. The use of sampling sleeves is not necessary if adequate decontamination is performed between sampling locations and or depths (unless they are specified in a work plan). If laboratory samples are not being collected, sample sleeves are usually not used.

3.4 Sample Containers

Select appropriate sample containers depending upon the analyses to be performed as described in the project Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP).

3.5 Field Logbook and Surface Soil Field Data Record

See FSP Appendix B.

3.5 Cooler and Ice or Ice Substitute

3.6 Stainless Steel Mixing Bowls

4.0 PROCEDURES

4.1 General

Specific sampling equipment and methodology will be dictated by the characteristics of the soil to be sampled, field conditions, the type of soil samples required by the project, and the analytical procedures to be employed. Soil samples obtained from the near-surface (0-2 feet below the ground surface) may be collected using a shovel or trowel. The type of analysis required (e.g., grain-size distribution, physical, chemical) may require specific soil amounts or the use of specialized sampling equipment.

Sampling locations or sampling design will be identified in the FSP.

A hand-auger can be used to extract shallow soil samples from depths as deep as three to four feet below the surface. Representative samples are collected directly from the auger flight as it is withdrawn from the ground, or from the tube sampler attached to the end of the rods.

Levels of personal protection will be described in the Health and Safety Plan (HASP).

4.2 Detailed Procedures

4.2.1 Select the Specific Sampling Location in Accordance with the Project Sampling Plan. Construct a sampling grid if necessary. Begin recording information on the Surface Soil Field Data Record. Prepare the sampling location by removing all surface materials that are not to be included in the sample (i.e., rocks, twigs, and leaves).

4.2.2 Select the Previously Decontaminated Type of Sampler Required to Obtain the Correct Sample. At the surface, use a shovel, trowel, or tube sampler; below surface, use a hand-auger or tube sampler.

4.2.3 Remove decontamination seals (i.e., aluminum foil/plastic wrap).

4.2.4 Obtain a sufficient quantity of soil for the desired chemical or physical analyses. If volatile organic compound (VOC) or volatile petroleum hydrocarbon (VPH) samples are scheduled, they should be collected immediately in accordance with SOP No. S-13 Field Preservation of volatile organic analysis (VOA) Soil Samples (See FSP Appendix B). The remaining soil should then be composited in a stainless steel bowl for all other analytical parameters.

4.2.5 When using the hand-auger, advance the auger to the required depth, then slowly remove the auger and collect the soil sample from the auger flight at the point corresponding to the required depth. Re-insert and continue augering if deeper samples are required. If samples are required from sandy or non-cohesive soil, use of a hand trowel or shovel may be necessary. Soil samples obtained directly from auger flights are, at best, composite samples over a portion of the auger hole. Samples should only be taken from auger-flights when composite samples are desired. Select the appropriate sample container and place the sample in the container. Describe the soil in accordance with SOP No. S-11 Procedures for the Description and Identification of Soils (See FSP Appendix B).

4.2.6 Cap and label the sample container. Record all observations on the Surface Soil Sampling Field Data Record Form and field logbook. Place samples into a cooler and begin specified storage and preservation procedures.

4.2.7 Decontaminate the sampler between collection points. Decontamination procedures will be performed as identified in SOP S-5, Decontamination of Field Equipment Procedure.

4.2.8 Initiate delivery of the samples to the designated Field Operation Leader or sample manager.

5.0 DOCUMENTATION

Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms include:

1. Field Logbooks
2. Surface Soil Sampling Field Data Record

6.0 REFERENCES

U.S.EPA, 1987. "A Compendium of Superfund Field Operations Methods".

SOP No. S-4

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

CALIBRATION OF FIELD INSTRUMENTS FOR WATER QUALITY PARAMETERS

STANDARD OPERATING PROCEDURE

CALIBRATION OF FIELD INSTRUMENTS FOR WATER QUALITY PARAMETERS

1.0 SCOPE AND APPLICABILITY

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for groundwater and surface water. Water quality instruments addressed in this SOP include those that measure temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, oxidation-reduction potential (ORP), and turbidity. Manufacturer manuals are included in the Quality Assurance Project Plan (QAPP) appendices (MACTEC, 2008).

This SOP is written for instruments that utilize multiple probes for temperature, pH, DO, conductivity/specific conductance, ORP, and turbidity. This SOP refers to instrumentation and outlines calibration procedures consistent with those discussed in U.S. Environmental Protection Agency (USEPA) Region I Standard Operating Procedure, *Draft Calibration of Field Instruments,* June 3, 1998.

For groundwater monitoring during well development and/or purging prior to sample collection, the multiple probe instrument must be equipped with a flow-through cell, and the display/logger or computer display screen should be large enough to simultaneously display the readouts of each probe in the instrument. Turbidity is measured using a separate instrument because turbidity cannot be measured accurately in a flow-through cell.

2.0 SUMMARY OF METHOD

All monitoring instruments must be calibrated before they are used to measure environmental samples.

Most instruments will require at least two standards to bracket the expected measurement range, one standard less than the expected value and one higher. At a minimum, calibration must be performed at the beginning of each sampling day prior to sample collection. Site-specific plans should be consulted for required calibration frequency. Note: Part of the instrument preparation and initial calibration is performed prior to the field event.

This SOP requires that the manufacturer's instruction manual (including the instrument specifications) accompany the instrument into the field.

3.0 DEFINITIONS

SOP	Standard Operating Procedure
pH	Potential of Hydrogen
ORP	Oxidation-Reduction Potential
NIST	National Institute of Standards and Technology
C	Celsius
mg	Milligram
L	Liter
DO	Dissolved Oxygen
mm	Millimeter
NTU	Nephelometric Turbidity Unit
PPE	Personal Protective Equipment
Sonde	Device that holds the measuring probes
SU	Standard Units
µg	Microgram

4.0 HEALTH & SAFETY WARNINGS

MACTEC Engineering and Consulting, Inc. (MACTEC) employees will be on site when implementing this SOP. Therefore, MACTEC personnel shall follow the site-specific Health & Safety Plan (HASP). MACTEC personnel will use the appropriate level of personal protective equipment (PPE), which includes the following:

1) hardhat;
2) safely boots (steel toe/steel shank);
3) safety glasses; and
4) chemical resistant gloves.

Implementing this SOP will require the use of calibration solutions. The following health and safety precautions must be taken with the pH, conductivity, and ORP solutions: Avoid inhalation, skin and eye contact or ingestion.

Maintenance of the instruments will require the use of liquid cleaners. Although these substances are not hazardous materials, MACTEC will appropriately handle and store them at times in accordance with manufacturer's instructions.

5.0 CAUTIONS & POTENTIAL PROBLEMS

Prior to calibration all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erroneous measurements.

Prior to using calibration standards, check all expiration dates.

Use a ring stand and clamp to secure the sonde in an upright position. This will prevent the sonde from falling over and damaging the probes.

The volume of the calibration solutions must be sufficient to cover both the probe being calibrated and the temperature sensor (see manufacturer's instructions for additional information).

While calibrating or performing sample measurements, make sure there are no air bubbles lodged between the probe and the probe guard.

DO content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic and or erroneous measurements. If the probe reading shows the error message "value out of range", the instrument probe must be recalibrated.

6.0 PERSONNEL QUALIFICATIONS

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all MACTEC personnel must be adequately trained.

Before implementing this SOP alone, MACTEC personnel must be trained in these procedures by a senior staff member with experience operating the equipment. In addition, all personnel utilizing this SOP must have completed the following:

- 40-hour OSHA training;
- 8-hour annual refresher training; and
- On-site training.

In addition to the 40-hour initial OSHA; training (and annual 8-hour refresher training), all MACTEC field staff will complete 24 hours of supervised field experience that contribute toward the 24-hour field supervised requirement in compliance with OSHA regulation: 29 CFR 1910.120(e)(4).

7.0 EQUIPMENT AND SUPPLIES

The following equipment should be used when calibrating water quality parameter measuring equipment. Site-specific conditions may warrant the use of additional items or deletion of items from this list.

- Appropriate level of personal protection
- Water quality meter capable of measuring pH, temperature, DO, specific conductivity, and ORP (e.g., YSI 600XL, or equivalent)
- Turbidity Meter (e.g., LaMotte 2020, or equivalent)
- Distilled water
- Deionized water
- Flow-through cell
- Ring stand with clamp
- Paper towels
- Soft tissue (e.g., Kimwipes)
- Cuvette
- pH buffer solutions (4, 7, 10 SU)
- Conductivity solution (100, 1000 µmhos)
- Zobell solution
- Turbidity standards (0.5, 20 NTU)
- Zero DO solution (0.0 milligrams per liter [mg/L])
- DO membrane kit (electrolyte solution, membranes)
- NIST thermometer (0.01 C accuracy)
- Small glass or polyethylene jars to hold the calibration standards (4-8 oz.)
- Calibration Logbook
- Field Instrument Calibration Field Data Record (See FSP Appendix A)
- Cup or spray bottle for the distilled water

8.0 PROCEDURES

The probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature by the instrument. Communications to the instrument (programming and displaying the measurement files) are performed using a display/logger or a computer. Information sent to the instrument is entered through the keypad on the display/logger or computer. It is desirable that the display/logger or computer have data storage capabilities. If the instrument does not have a keypad, follow the manufacturer's instructions for entering information into the instrument.

- Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature, pH, percent DO, mg/L dissolved oxygen, conductivity, specific conductance, and ORP.
- For instrument probes that rely on the temperature sensor (pH, DO, conductivity/specific conductance, and ORP), each temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). Before any instrument is calibrated or used to perform environmental measurements, the instrument must stabilize (warm-up) according to manufacturer's instructions.

<u>Temperature</u>

Most instrument manuals state that calibration of the temperature sensor is not required, but this SOP requires that the temperature sensor be checked to verify its accuracy. This accuracy check is performed at least once per year and the accuracy check date/information is kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was performed over a year prior to the date of use, it is recommended that the temperature sensor accuracy be checked at the beginning of the sampling event. If the instrument contains multiple temperature sensors, each sensor must be checked.

VERIFICATION PROCEDURE

1. Allow a container filled with water to equilibrate to ambient temperature.
2. Place a NIST -traceable thermometer and the instrument's temperature sensor into the water and wait approximately five minutes for both temperature readings to stabilize.
3. Compare the two measurements. The instrument's temperature sensor must agree with the NIST -traceable thermometer measurement within the accuracy of the sensor (usually to +/-15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

<u>Dissolved Oxygen</u>

DO is the volume of oxygen that is dissolved in water and is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic or erroneous measurements.

CALIBRATION PROCEDURE

1. Gently dry the temperature sensor according to manufacturer's instructions.
2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container that comes with the instrument.
3. Place the DO probe in the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit loosely in the container to ensure it is vented to the atmosphere.
4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn on the instrument to allow the

DO probe to warm up. Select monitoring/run mode. Check temperature readings. Readings must stabilize before continuing to the next step.

5. Select calibration mode; then select "DO%".

6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement can be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location and unless this is the only source of barometric data. [Note: inches of mercury times 25.4 mm/inch mercury equals mm of mercury].

7. The instrument should indicate that the calibration is in progress. After calibration, the instrument should display percent saturated DO. Check the reading against the Temperature Atmospheric Pressure table in Attachment A. For example, if the barometric pressure is 752 mm Hg at an elevation of 278 feet, the percent saturation value after calibration should be 99%.

8. While the probe is still in the calibration cup, select monitoring/run mode. Compare the DO mg/L reading to the Oxygen Solubility at Indicated Pressure chart in Attachment B. For example, if the barometric pressure is 750 mm Hg and the temperature inside the calibration cup is 20°C, the DO mg/L reading should be 8.94 mg/L. If they do not agree to the accuracy of the instrument (usually ±0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution and repeat calibration.

9. Remove the probe from the container, rinse it with distilled water, pat it dry with a towel and place it into a 0.0 mg/L DO Standard. The standard must be filled to the top of its container and the DO probe must fit snugly into the standard's container (no headspace). Check temperature readings. They must stabilize before continuing.

10. Wait until the "mg/L DO" readings have stabilized. The instrument should read < 0.5 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L) within 30 seconds. If the instrument cannot reach this value, it will be necessary to clean the probe and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L standard. If these measures do not work, contact the manufacturer.

<u>pH (electrometric)</u>

The pH is the measure of the degree of the acidity or alkalinity of a solution as measured on a scale of 0 to 14. The pH of a sample is determined electrometrically using a glass electrode. All pH measurements are in standard units (SU).

Choose the appropriate buffered standards that will bracket the expected values at the sampling locations. For groundwater, the pH will usually be close to seven. Three standards are needed for the calibration: one close to seven, one at least two pH units below seven and the other at least two pH units above seven. For those instruments that will not accept three standards, the instrument will need to be recalibrated if the water sample's pH is outside the range defined by the two standards used in the initial calibration.

CALIBRATION PROCEDURE

1. Allow the buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.

3. Remove the cover of the probe, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.

4. Select monitoring/run mode. Immerse probe in the initial buffered standard (e.g., pH 7) and allow at least 1 minute for temperature equilibration before proceeding.

5. Enter the buffered standard value (7) into the pH calibration menu of the instrument. Allow the pH reading to stabilize for approximately 30 seconds and if the reading does not change, finish the calibration. The reading should remain within the manufacturer's specifications; if it changes, recalibrate. If readings continue to fluctuate or readings do not stabilize after recalibration, consult the manufacturer.

6. Remove probe from the initial buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.

7. Immerse probe into the second buffered standard (e.g., pH 4). Repeat step 5 substituting "4" into the pH calibration menu instead of "7".

8. Remove probe from the second buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue. If the instrument *only* accepts two standards the calibration is complete. Proceed to step 11. Otherwise continue with step 9.

9. Immerse probe m third buffered standard (e.g., pH 10). Repeat step 5, substituting "10" into the pH calibration menu instead of "7".

10. Remove probe from the third buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.

11. Select monitoring/run mode, if not already selected. To ensure that the initial buffered calibration standard (e.g., pH 7) has not changed, immerse the probe into the initial standard. Wait for the reading to stabilize. The reading should read the initial standard value (e.g., 7) within the manufacturer's specifications. If not, re-calibrate the instrument. If re-calibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

<u>Specific Conductance</u>

Conductivity is used to measure the ability of an aqueous solution to conduct an electrical current. Specific conductance is the conductivity value corrected to 25°C. Calibrating an instrument for specific conductance automatically calibrates the instrument for conductivity, and vice-versa.

Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements.

CALIBRATION PROCEDURE

1. Allow the calibration standard to equilibrate to the ambient temperature.

2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe

into the conductivity/specific conductance standard. Gently move the probe up and down in the solution to remove any air bubbles from the sensor. Allow the probe to sit in the solution for at least l minute for temperature equilibration before proceeding.

3. Select calibration mode.

4. Select Specific Conductance from the Calibration menu. Enter the calibration value of the solution (mS/cm at 25°C) and continue. Allow the Specific Conductance reading to stabilize for approximately 30 seconds and finish the calibration. The reading should remain within manufacturer's specifications. If it does not, recalibrate. If readings continue to change after recalibration, consult the manufacturer.

5. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, re-calibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.

NOTE: These procedures should only be used for instruments that are capable of automatically correcting specific conductance for temperature (to 25°C). For instruments that cannot calibrate for specific conductance, follow the procedures in the instrument's manual for conductivity calibration. If calibrating for conductivity instead of specific conductance, the solutions conductivity value must be corrected for the temperature that the sensor is reading.

Oxidation-Reduction Potential

The ORP is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts (mV) and is temperature dependent.

CALIBRATION OR VERIFICATION PROCEDURE

1. Allow the calibration standard (a.Zobell Solution) to equilibrate to ambient temperature.

2. Remove the cover of the probe and place it into the standard.

3. Select monitoring/run mode.

4. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.

5. Look up the mV value at this temperature from the mV versus temperature correction table found in Attachment C. It may be necessary to interpolate mV values between temperatures. Select “calibration mode”, then "ORP". Enter the temperature corrected ORP value and calibrate the instrument.

6. Select monitoring/run mode. The reading should remain unchanged within manufacturer's specifications. If it changes, recalibrate. If readings continue to change after calibration, consult manufacturer.

7. If the instrument instruction manual states the instrument is factory calibrated, then verify the factory calibration against the standard. If reading does not agree within the

specification of the instrument, the instrument will need to be re-calibrated by the manufacturer.

Turbidity

Turbidity refers to how clear the water is and is a measure of relative sample clarity. The greater the amount of total suspended solids in the water, the higher the measured turbidity. The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidity meter is a nephelometer with a visible light source for illuminating the sample and one or more photoelectric detectors placed ninety degrees to the path of the light source.

Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

CALIBRATION PROCEDURES

1. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.
2. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette, respectively.
3. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.
4. Using a standard at I NTU, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read the standard value to within the specifications of the instrument. If the instrument has a range of scales, check each range that will be used during the sampling event with a standard that falls within that range.
5. Using a standard at 10 NTU, calibrate according to manufacturer's instruction or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read the standard value to within the specifications of the instrument.

Note: If only performing a two-point calibration (depending on project requirements), the 0.02 NTU and 10 NTU standard should be used.

9.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

Prior to calibrating, the field equipment and calibration standard information should be recorded on a separate Field Instrument Calibration Field Data Record (See FSP Appendix C). For field equipment, the information recorded should include the make, model number and the serial number of the instrument.

Each instrument can be assigned an identification number which can be referenced in future field notes or when filling out the Field Instrument Calibration Field Data Record.

For calibration standards, the information recorded should include the manufacturer, expiration date, true value, and standard description such as lot number. Each calibration standard can also be assigned an identification number which can be referenced in future field notes or when filling out the Field Instrument Calibration Log.

All standards should be initialed and dated when opened.

At a minimum, the log must include the instrument information described above, calibration standard information described above, calibration date and time, and the instrument calibration results.

10.0 REFERENCES

MACTEC, 2007. "Quality Assurance Project Plan"; Olin Chemical Superfund Site; Date – to be determined.

USEPA Region I, June 3, 1998. *Standard Operating Procedure, Draft Calibration of Field Instruments.*

USEPA Region I, July 30, 1996. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples for Monitoring Wells.*

SOP No. S-5

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

DECONTAMINATION OF FIELD EQUIPMENT

STANDARD OPERATING PROCEDURE

DECONTAMINATION OF FIELD EQUIPMENT

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the methods to be used for the decontamination of all field equipment which becomes potentially contaminated during a sample collection task. The equipment may include split-spoons, bailers, trowels, shovels, hand-augers, or any other type of equipment used during field activities.

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross-contamination between samples and also helps to maintain a clean working environment for the safety of all field personnel.

Decontamination is mainly achieved by rinsing with liquids which may include: soap and/or detergent solutions, tap-water, deionized water, acid solutions, and methanol. Equipment will be allowed to air dry after being cleaned or may be wiped dry with clean cloths or paper towels if immediate re-use is needed.

The frequency of equipment use dictates that most decontamination be accomplished at each sampling site, between collection points. Waste products produced by the decontamination procedures, such as waste liquids, solids, rags, gloves, etc. must be collected and disposed of properly. All decontamination materials and wastes should be stored in a central location so as to maintain control over the quantity of materials used and/or produced throughout the study.

2.0 RESPONSIBILITIES

It is the primary responsibility of the project Field Operations Leader and field samplers to assure that the proper decontamination procedures are followed and that all waste materials produced by decontamination are properly stored and disposed of.

It is the responsibility of the project safety officer to draft and enforce safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

It is the responsibility of any subcontractors (i.e., drilling contractors) to follow the proper designated decontamination procedures that are stated in their contracts and outlined in the Project Health and Safety Plan.

It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and to ensure that any contaminants are not negligently introduced to the environment.

3.0 EQUIPMENT AND MATERIALS

3.1 Cleaning Liquids

Cleaning materials may include tap (potable) water, deionized water, and soap and/or detergent solutions, nitric acid solutions, and methanol. For the Olin site, only deionized water and liquinox will be used unless specified in the FSP for a specific sampling location.

3.2 Personal Safety Gear

Personal protective equipment (PPE) will be defined in Project Health and Safety Plan.

3.3 Paper Towels

3.4 Disposable Gloves

3.5 Waste Storage Containers

Drums, boxes, plastic bags

3.6 Cleaning Containers

Plastic buckets, galvanized steel pail

3.7 Cleaning Brushes

3.8 Stainless Steel Spray Bottles

4.0 PROCEDURES

4.1 General Approach

4.1.1 All equipment that comes in contact with the media that is sampled should be included in the decontamination process.

4.1.2 The standard procedures listed in the following section can be considered the procedure for full field decontamination. If different or more elaborate procedures are required for a specific task, they will be spelled out in the FSP. Such variations in decontamination may include following all, just part, or an expanded scope of the decontamination procedure stated herein.

4.2 Soil Sampling Equipment

4.2.1 Remove any solid particles from the equipment or material by brushing and then rinsing with clean water. This initial step is performed to remove gross contamination.

4.2.2 Wash equipment with a soap or detergent solution and brush.

4.2.3 Rinse with tap-water.

4.2.4 Rinse with deionized water.

4.2.5 Repeat entire procedure or any parts of the procedure if necessary.

4.2.6 If sampling equipment is to be used immediately at another location, wrap the equipment in aluminum foil and store in a safe place.

4.3 Submersible Pump Decontamination Procedures

This procedure will be used to decontaminate submersible pumps (if used) and pump tubing between groundwater sample collection points and at the end of each day of use. For wells where dedicated tubing is being used, no decontamination of the tubing is needed. The dedicated tubing will be placed back into the monitoring well and only the pump will be decontaminated as described in the following subsections.

The following materials will be used:

- plastic-nalgene or PVC upright cylinder
- 5-10 gallon plastic water storage containers

- Deionized water
- Stainless steel spray bottle
- Paper towels

4.3.1 During decontamination the submersible pump will be placed on a clean surface (sheet of plastic) or held away from ground.

4.3.2 Clean the upright plastic-nalgene/PVC cylinder as described above in Section 4.2.

4.3.3 Decontaminate the outer surface of the submersible pump and the entire tubing using a potable water rinse followed by a deionized water rinse.

4.3.4 Place the submersible pump upright in the cylinder and fill the cylinder with potable water.

4.3.5 Activate the pump in the forward mode withdrawing water from the cylinder.

4.3.6 Continue pumping until the water in the cylinder is pumped down and air is drawn through the pump. If tubing is being decontaminated, continue pumping water through the pump until the tubing is full and overflowing. Continue pumping a volume of water that is twice the volume needed to fill the tubing and run the pump to dryness. At this time air pockets will be observed in the discharge line. Shut off the pump immediately.

4.3.7 Using the water remaining in the cylinder, rinse the sealed portion of the power cord and discharge tube by pouring the water carefully over the coiled lines.

4.3.8 Repeat steps 4.3.4 through 4.3.7 using deionized water. Pump or drain all the remaining water from the tubing.

4.3.9 When reaching the next monitoring well place the pump in the well casing and wipe dry both the power and discharge lines with a clean paper towel as the pump is lowered.

5.0 REFERENCES

U.S. Environmental Protection Agency (USEPA), January, 1986. "Decontamination Techniques for Mobile Response Equipment Used at Waste Sites (State-of-the-Art Survey)." EPA/600/52-85/105.

USEPA, March, 1985. "Guide for Decontaminating Buildings, Structures, and Equipment at Superfund Sites." EPA/600/2 85/028.

SOP No. S-6

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

MONTORING WELL DEVELOPMENT

STANDARD OPERATING PROCEDURE

MONTORING WELL DEVELOPMENT

1.0 SCOPE AND APPLICABILITY

This standard operating procedure describes the protocol to be followed during the development of monitoring wells.

1.1 Objective

The objectives of monitoring well development are to remove sediment that may have accumulated during well installation, to consolidate the filter pack around the well screen, and to enhance the hydraulic connection between the target zone and the well.

2.0 EQUIPMENT

The following equipment may be used during well development. Site-specific conditions may warrant addition or deletion of items from this list.

- Submersible pump, peristaltic pump, and/or bailer;
- Surge block;
- Container for purge water, if required.(drums or fractionation tank);
- Container with known volume (e.g., 5-gallon bucket) for flow estimation;
- Water level indicator;
- Stopwatch or timer;
- Clear glass jars (at least 2);
- Well Development Field Data Record (See FSP Appendix B);
- Field logbook; and
- Pens.

3.0 PROCEDURES

3.1 General Considerations

Monitoring well development shall be performed no sooner than 48 hours following placement of the grout seal. Weather conditions may increase grout set time and, consequently, further delay development if needed.

The primary objective of well development of environmental monitoring wells is to ensure that an appropriate hydraulic connection is established so that the well will serve its intended purpose to provide water quality and/or head elevation head data.

3.2 Specific Procedures

Development of wells shall be accomplished with a submersible pump, peristaltic pump, or a dedicated bailer. Bailers shall be used to develop wells only where the volume of water is so small that other development methods are clearly inappropriate. Pumps used for well development shall be periodically raised and allowed to drain back into the hole in order to induce flow out through the well screen.

A surge block may be used to flush the filter pack of fine sediment in instances where field personnel expect that development may be improved by surging. Surging will be conducted slowly to reduce disruption to the filter pack and screen. Following surging, the well will be pumped or bailed again to remove sediment drawn in by the surging process until suspended sediment is reduced to acceptable levels (see below). Water shall not be added to the well to aid in development.

Small-diameter wells shall be developed with an inertial pump to remove silt and fine sand that enter through screen slots immediately following well installation. Pumping shall continue from the screened interval until a volume of water equal to or greater than three saturated well volumes has been purged.

A well is considered fully developed when all the following criteria are met:

- the well water is clear to the unaided eye (based on observations of water clarity through a clear glass jar);
- the sediment thickness remaining in the well is less than one percent of the screen length; and
- the total volume of water removed from the well equals five times the standing water volume in the well (including the well screen and casing plus saturated annulus, assuming 30 percent porosity) plus the estimated volume of drilling fluid lost.

These criteria may be modified with approval by the field manager. Should the recharge to the well be so slow that the required volume cannot be removed in 2 to 3 consecutive hours, if the water remains discolored, or excess sediment remains after the five-volume removal, the project team shall terminate purging and/or discuss other options for improving water quality. Limited development may be specified when gross contamination is observed (e.g., the presence of NAPL).

The cap and all internal components of the well casing above the water table shall be rinsed with deionized water to remove all traces of soil, sediment, and cuttings. This washing shall be conducted before and/or during development.

Non-dedicated pumps shall be decontaminated prior to use in the next well and dedicated tubing and/or bailers shall be used during subsequent sample collection from the well. Development fluids (IDW) shall be handled as described in the FSP (Section 5).

4.0 DOCUMENTATION

The following data shall be recorded on the Monitoring Well Development Field Data Record (see FSP Appendix C):

- well designation;
- date of well installation;
- date of development;
- static water level before and after development;
- quantity of drilling fluid lost during drilling (estimated);
- quantity of standing water in well and annulus (30-percent porosity of saturated annulus assumed for calculation) prior to development;
- depth from top of well casing to bottom of well;
- screen length;
- depth from top of well casing to top of sediment inside well, before and after development;
- physical character of removed water, including changes during development in clarity, color, particulates, and odor;
- type and size/capacity of pump and/or bailer used;
- height of well casing above/below ground surface;
- typical pumping rate;
- estimate of recharge rate; and
- quantity of water removed and time for removal.

SOP No. S-7

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

PROCEDURES FOR MEASURING GROUNDWATER LEVELS

STANDARD OPERATING PROCEDURE

PROCEDURES FOR MEASURING GROUNDWATER LEVEL

1.0 SCOPE AND APPLICABILITY

Procedure to measure groundwater levels in monitoring wells or piezometers. In general, water levels will be measured prior to purging wells and collecting groundwater samples. Water level data acquired may be used to assess hydraulic gradients, perform drawdown tests, etc.

2.0 EQUIPMENT AND MATERIALS

2.1 Measurement

- Electronic water level meter
- Well keys and wrenches (include an extension for keys and wrenches to apply extra leverage), screwdriver, hammer
- Photoionization detector (PID), or other monitoring equipment (as required by Health and Safety Plan)

2.2 Documentation

- Well installation logs, boring logs
- Field book
- Field Data Record (if used)
- Permanent marker

2.3 Decontamination

Tap or spring water, Liquinox™, distilled/deionized water, brush, paper towels

2.4 Health and Safety Equipment per Work Plan

3.0 PREPARATION

Inspect the meter's probe to ensure that it is clean and has been decontaminated after previous uses. Test the probe to verify that it is functioning.

4.0 PROCEDURES

4.1 Well Condition

Check the condition of the standpipe or roadbox and protective seal, if any. Observe and record any abnormalities with the well such as a missing cap, run-on, evidence of tampering, missing/rusted/open lock, damaged roadbox or standpipe, etc. Record observations in the field logbook and Field Data Record, if used.

4.2 Health and Safety Monitoring

Depending upon the requirements of the site-specific Health and Safety Plan, screen the wellhead during removal of the cap with a PID or other monitoring equipment (as required by the Health and Safety Plan). Follow requirements for use of personal protective equipment.

4.3 Ground Water Elevation Reference Point

4.3.1 Record the type of measurement reference point used (i.e., roadbox, standpipe, mark on PVC).

4.3.2 If not already done, mark the measurement reference point either by etching or with indelible ink at the top of the PVC riser pipe or steel casing. The measurement reference point will generally be the highest point of the PVC riser or casing. Mark well number on the outside of well if not otherwise permanently marked.

4.4 DNAPL or LNAPL (Determine if project-specific requirements apply)

4.4.1 If indicated in the FSP or other planning document, check for the presence and measure the thickness of light or dense non-aqueous phase liquid using a transparent bailer, product-water interface probe, or water-sensitive paste (LNAPL). If LNAPL is observed, do not immerse the electronic water level meter unless specifically required by the Work Plan. Measure and record thickness of NAPL.

4.4.2 To use a bailer to measure NAPL, lower it slowly into the water column using a polypropylene or nylon line. For LNAPL, hold the bailer so that the bottom check valve and approximately half the bailer's length are submerged; for

DNAPL, lower the bailer to the bottom of the well. Hold the bailer at the appropriate level for about 10 to 30 seconds to allow NAPL to enter the bailer.

4.4.3 If the well is known to contain LNAPL, an interface probe should be used to give a more accurate measurement of the product thickness. Lower the probe down the well, similarly to the water level meter. The probe sounds differently when it has detected LNAPL and when it has detected water. The difference between the two tones indicates the product thickness.

4.5 Well Depth

Sound well depth and record to the nearest 0.01 feet. Compare to installed depth of well.

4.6 Water Level Measurement

4.6.1 Slowly lower the water level meter's probe into the well until the auditory signal indicates that water is reached.

4.6.2 Raise the probe above water level and slowly lower it again until the exact position of the water is indicated on the tape gauge.

4.6.3 Hold the cable or tape against the side of the PVC riser or steel casing at the reference point designated for water level measurements and record the measured depth to the nearest 0.01 feet.

4.6.4 If no additional work is to be performed, lock or secure the wellhead.

5.0 DECONTAMINATION

- Inspect meter and tape for the presence of free product. If present, decontaminate accordingly.
- If contaminates are suspected, perform a gross decon by wiping the tape with a paper towel as it is retrieved from the well.
- Rinse with tap or bottled water.
- Rinse with distilled/deionized water.
- Containerize and handle decontamination wastes and wastewater in accordance with specifications in the FSP.

SOP No. S-8

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPMENT

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPMENT

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes methodologies for shipping samples collected during environmental field investigation/remediation activities. This SOP applies to all environmental samples including drinking water, groundwater, surface water samples, soil, and sediment samples, and treatment plant samples.

2.0 DEFINITIONS

Shipper's Declaration – A paper document describing the contents of a shipment.

3.0 HEALTH AND SAFETY WARNINGS

Shippers of dangerous goods should take all precautions to eliminate any hazards associated with the goods being shipped. The shipper should consult the most-recent version of the International Air Transportation Association (IATA) regulations regarding shipment of dangerous goods.

4.0 PERSONNEL QUALIFICATIONS

Any person designated as a shipper of dangerous goods shall be trained in the U.S. Department of Transportation Hazardous Materials Regulations, which must be renewed every two years.

Shipment of environmental samples does not require specialized training; however, a familiarity with the regulations and the materials being shipped is considered beneficial.

5.0 EQUIPMENT AND SUPPLIES

Consult the most-recent version of the IATA regulations for a listing of proper shipping materials.

- Cooler
- Samples
- Labels
- Ink pen

- Packing materials (bubble wrap) to prevent breakage, absorb leakage, and insulate samples.
- Polyethylene zip-type baggies large enough to contain the largest sample bottles.
- Custody seals if shipped through Federal Express (FEDEX) or similar shipping vendor.
- Large plastic trash bag to act as containment for the packing materials.

6.0 PROCEDURES

1) Be certain that all containers are sufficiently tight, preserved, and labeled correctly. Sediment samples should be allowed to settle for a minimum of 2 hrs prior to shipping to the laboratory. The sample manger should look closely at all sediment samples to see if a clear water layer forms above the sediment. Any water layer should be decanted from the sample jar prior to shipping to the laboratory.
2) Clean the exterior of each sample container such that no gross contamination remains.
3) Complete the Chain of Custody (COC) as described SOP S-9. When the COC form is completed, verify that bottle labels, analytical fractions, and bottle numbers match what is written on the COC form.
4) Wrap sample containers in bubble wrap. Zip-type plastic baggies may be used as additional containment.
5) Line the cooler with the trash bag and add a layer of packing material. If the cooler has a drain, close and seal to prevent leakage of water from melting ice.
6) Place sample containers into the cooler, and pack them sufficiently to prevent them from shifting during shipment.
7) Place ice-filled zip-type bags on samples such that all samples are contacted by the ice. Place sufficient ice to retain the sample temperature between 2 and 6 degrees C. Place a temperature blank in with the samples.
8) Fill the remaining space in the cooler with packing material and close and secure the top of the trash bag.
9) On the chain of custody, sign in the relinquished by box and add in the subsequent received by box the name of the courier/carrier and the air bill No. (if applicable).
10) Place the COC into a plastic bag and tape it to the inside top of the cooler.
11) Close the cooler and tape the cooler shut with strapping tape or similar high-strength shipping tape.
12) If more than one cooler is being shipped under the same COC, copies of the COC should be placed into each additional cooler in the same manner as the original COC.
13) If shipped through FEDEX or other shipping vendor, apply custody seals to the cooler such that the seals must be broken in order to open the cooler.
14) Apply “UP Arrows” in the appropriate direction on at least opposing sides of the cooler exterior, or indicate on top “this side up”.

15) Add the appropriate shipping address labels to the cooler along with a return address to the cooler. If more than one cooler is being shipped, add “one of ____” to the label so that the recipient is aware that more than one cooler should be received.

7.0 DATA AND RECORDS MANAGEMENT

A copy of the COC shall be retained by the shipper until the completed laboratory data package is received. In addition, a copy of the air bill shall also be retained for validation/custody purposes and also for payment.

8.0 REFERENCES

MACTEC Engineering and Consulting, Inc. Standard Operating Procedure for Chain of Custody S-9

Code of Federal Regulations 40 CFR Part 261.4(d) Samples.

Dangerous Goods Regulations, IATA, Most-Current Version.

SOP No. S-9

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

SAMPLE CHAIN OF CUSTODY PROCEDURE

STANDARD OPERATING PROCEDURE

SAMPLE CHAIN OF CUSTODY PROCEDURE

1.0 INTRODUCTION

This SOP describes chain of custody procedures to be followed whenever collecting environmental samples. This SOP is referenced in all SOPs for environmental sample collection.

2.0 CROSS-REFERENCES

- ASTM D4840-95: Guide for Sampling Chain-of-Custody Procedures
- U.S. EPA Region 4 "Environmental Investigations Standard Operating Procedures and Quality Assurance Manual," May 1996 Including 1997 Revisions
- Site-specific Health and Safety Plan

3.0 MATERIALS

3.1 Documentation

- Work Plan
- Field Data Records (FDR)
- Chain-of-custody forms
- Sample labels
- Field logbook
- Permanent marker
- Lab contact information
- Chain-of-Custody Form

4.0 PREPARATION

Review Work Plan to identify samples to be collected, analyses to be performed, laboratory performing the analyses, and any other project specific-objectives of the sampling program. Review sample collection SOPs for media being sampled.

5.0 SAMPLE LABELING

Enter in the log book and label each sample container with the following information:

a) Olin project number

b) Date and time of collection

c) Sample location

d) Sample number

e) Analysis to be performed

f) Sampler's initials

g) Preservative

If using field sample tracking system labels will be generated and printed by the field sample coordinator.

6.0 CHAIN OF CUSTODY

6.1 Definition

EPA provides the following definition of chain-of-custody:

“A sample is considered to be in your custody if any of the following criteria are met:

- The sample is in your possession or is in your view after being in your possession;
- The sample was in your possession and then locked up or sealed to prevent tampering; or
- You have placed the sample in a secured area.”

6.2 Purpose

"The chain-of-custody form is functionally similar to a packing slip that accompanies a shipment of goods. The chain-of-custody form includes a chain-of-custody record located at the bottom of the form. The form is used as physical evidence of sample custody. EPA guidelines specify that official custody of samples must be maintained and documented from the time of collection until the time the samples are introduced as evidence in the event of litigation. The sampler is responsible for the care and custody of the sample until sample shipment."

6.3 Documentation

6.3.1 After samples are collected and labeled, fill out the chain-of-custody form. Examples of computer generated COC forms and hand written laboratory COC forms that may be used are presented in Attachment A of this SOP. The sampler becomes the initial sample custodian.

6.3.2 Chain-of-custody forms must be completed for every shipment of samples to an analytical laboratory.

6.3.3 Use indelible ink only, no pencil (a ball point pen is best). Make corrections by drawing a line through and initialing and dating the error, then enter the correct information. Erasures are not allowed.

6.3.4 A separate chain-of-custody form must accompany each cooler for each shipment. Place the original COC form in a zipper-type plastic bag in the cooler with the samples. The chain-of-custody forms must address all samples in that sample shipment. If multiple coolers are shipped a copy of the COC should accompany each cooler. This practice maintains the chain-of-custody for all samples in case of mis-shipment.

6.4 Transfer of Custody

6.4.1 When transferring the possession of samples, the individuals relinquishing and receiving custody will sign, date, and note the time on the record. Persons receiving the custody of a sample group are responsible for confirming the accuracy of the COC with regard to the number and type of sample containers for which they are accepting responsibility.

6.4.2 When samples are to be shipped to an analytical facility by commercial delivery service, the samples will be relinquished to the courier in sealed containers, and, if practicable, the shipment number will be noted on the COC form. When samples are transferred by commercial delivery service, a copy of the shipping documentation will serve as the COC record for the delivery service's role in the chain of custody.

6.4.3 The sample custodian relinquishing custody to a facility or agency will request the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this will be noted in the "Received by" space on the COC. When appropriate, the custody record will contain a statement that the samples were delivered to the designated location at the designated time.

Attachment A

Example of Olin Chain of Custody

Computer Generated Chain Of Custody

Olin Chemical Superfund Site

MACTEC E&C

Lab:

Sample #	Sample Date	Sample Time	Field Sample ID	Qty Total	Qty Each	Bottle Size and Material		Preservative	Media	Method	Fraction
556	10/25/2207	16:20	ATMW012XXX03XX	5							
					2	1 Liter	Amber Glass	4 deg.C	GW	PCBs -8082	T
					1	500 mL	Poly	HNO3,4 deg.C	GW	TAL Metals + Mo -6010B / 7470A	T
					2	40 mL	Glass Vial	HCL, 4 deg.C	GW	VOCs -8260B + TICs	T
558	10/25/2207	16:20	ATMW012XXX03XX	4							
					2	1 Liter	Amber Glass	4 deg.C	GW	SVOCs -8270C + TICs	T
					2	40 mL	Glass Vial	HCL, 4 deg.C	GW	VOCs -8260B + TICs	T

Relinquished:________________ Date: ___/___/____ Time:_____ Received:______________ Date: ___/___/_____ Time:____

Relinquished:________________ Date: ___/___/____ Time:_____ Received:______________ Date: ___/___/_____ Time:____

Hand Written Laboratory Chain of Custody Form

TestAmerica, Inc.
Chain of Custody Form

•53 Southampton Road
Westfield, MA 01085
(P) 413-572-4000
(F) 413-572-3707
Westfield

•148 Rangeway Road
N. Billerica, MA 01862
(P) 978-667-1400
(F) 978-667-7871
Boston - Service Center

Client: ______ Client Project #: ______ **Job#** ______ **Quote#** ______ **PO#** ______

Address: ______ Site ID & State: ______ **Shaded areas for office use**

Reports Sent To: ______ Invoice same as Report to? ☐

Comments
(Special Instructions)

Phone: ______ Fax: ______ Email: ______ Email Rpt: ☐

If Invoice contact or address different, note in Comments

Please print legibility. If the analytical requests are not clearly defined on the chain-of-custody, the turnaround time will begin after all questions have been satisfactorily answered.

Requested Turnaround Time (PLEASE SPECIFY)

STANDARD ______ **RUSH** ______ ***(Lab Approval Required)***

Regulatory Programs/Presumptive Certainty/QC Forms

MADEP MCP ☐ GW1/S1 ☐ PWS DEP Forms ☐
CTDEP RCP ☐ CT RSR ☐ EDD Required ☐
QA Rpt: No QC ☐ Std QC Rpt ☐ CLP QC Rpt: ☐

500-series for drinking water
600-series for waste water, NPDES
6000-series for groundwater, soil, waste
8000-series for groundwater, soil, waste
Use comments section to further define.

Sample Type Codes: WW-Wastewater, DW-Drinking Water, SW-Surface Water, GW-Groundwater, LW Lab Water, A-Air, "Z"-Other (please specify)

Comments:

Sample I.D.	Sample Type	Sampler's Initials	Date / Time Collected	Grab	Comp.	# Containers	Plastic(P) or Glass(G)	Preservative: NaHSO4/MeOH	Preservative: HNO3 to pH <2	Preservative: H2SO4 to pH <2	Preservative: HCl to pH <2	Preservative: NaOH to pH >12	Preservative: Na2S2O3	Preservative: None / 4° C	524 / 624 / 8260	525 / 625 / 8270	PCB / Pest / Herbicide	EPH / VPH	DRO / GRO / ETPH	Metals (Please Specify)	Mercury	General Chemistry	Bacteriological	Toxicity			

Sampled by (print): ______ Signature: ______

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

Cooler ? Y / N **MADEP Requirement Samples Iced? Y / N**

Temp @ receipt: ______ **°C**

Preservation / pH checked? Y / N

By: ______ **Date:** ______

TestAmerica WESTFIELD

Page____ of ____

White = Lab file Yellow = Report copy Pink = Customer copy

WI-QA-010 Rev 3a

STL-8245 (1000)

SOP No. S-10

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

USE OF FIELD LOGBOOKS

STANDARD OPERATING PROCEDURE

USE OF FIELD LOGBOOKS

1.0 SCOPE AND APPLICABILITY

The use of a Site Logbook and Field Logbook provides a daily record of significant events, observations, and measurements during field investigations. A site logbook is the master log for recording activities during an investigation. Field logbooks provide data and observations which will enable field personnel to reconstruct field project events. Sufficient data and observations should be logged in the field logbook to enable reconstruction of field events and to provide sufficient evidence in the event of legal proceedings.

2.0 RESPONSIBILITIES

It is the responsibility of the Field Operation Leader (FOL) to maintain centralized daily log book records of all significant field events, observations, and measurements during field investigations. All members of the field team are responsible for maintaining complete records of their actions, observations, etc. in their log books and providing this information to the team leader at the end of each day. If observations and measurements are taken in an area where the field log book may become contaminated or if the field personnel are spread over a large area, separate waterproof bound and numbered field log books may be maintained. Logbook entries should be signed and dated at the completion of each task or at the end of each day. Individual field log books are retained by the field team members until the logbook is filled or the completion of the project, at which time, possession of the log books is transferred to the FOL or project manager.

Errant field entries shall have a single line drawn through them and the correct data entered above it. All corrections shall be initialed and dated by the appropriate field personnel. Individual pages should never be removed from bound logbooks.

3.0 EQUIPMENT DESCRIPTIONS

A waterproof, bound field notebook and indelible ink pen are the standard field equipment.

4.0 ROCEDURES

The title page of each logbook will contain the following:

- The logbook number
- Project name and project number
- Site name (Olin Chemical Superfund Site) and address (51 Eames Street, Wilmington, MA)
- Logbook start date

The site logbook and field logbooks provide a daily hand written account of all field activities. All entries are made in permanent black or blue ink, and corrections are made with a single line with the author initials and date. Each page of the logbook will be dated and signed by the person completing the log. Partially completed pages will have a line drawn through the unused portion at the end of each day.

<u>Site Logbook</u>

The site logbook is a record of all major tasks completed for each day or operation. Entries are made each day. The FOL responsible for on-site field operations will complete the site logbook. At a minimum the site logbook will contain the following information:

- A list of all field logbooks created for the project;
- Names and titles of all project related personnel present at the site during each day of operation;
- A brief summary of all activities completed for each day of operation;
- A listing of any changes made to established SI/RI program procedures; and,
- A summary of any problems encountered during the day including a description of corrective actions and impacts on the project.

<u>Field Logbook</u>

Field logbooks are daily records of field task activities that are entered in real time by the on-site field technicians and scientists. The following information is entered into the field logbooks:

- The date and time of each entry. The daily log should begin with weather conditions and the names and organizations of personnel performing the documented task;
- A summary of important tasks or subtasks completed during the day;
- A description of any field tests completed in association with the daily task;

- A description of any samples collected including documentation of any quality control samples that were prepared (rinse blanks, duplicates, matrix spikes, split samples);
- Documentation of equipment maintenance and decontamination activities; and,
- A summary of any problems encountered during the day including a description of corrective actions and impacts on the daily task.

SOP No. S-11

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

PROCEDURE FOR DESCRIPTION AND IDENTIFICATION OF SOILS

STANDARD OPERATING PROCEDURE

PROCEDURE FOR DESCRIPTION AND IDENTIFICATION OF SOILS

1.0 SCOPE AND APPLICABILITY

The appearance and textural properties of soil samples will be described using the Unified Soil Classification System (USCS). The USCS uses grain size to divide soils into different soil classes, coarse grained vs. fine grained. The system then further describes the soils based on the mix of coarse materials such as sand and gravel or the relative plasticity of the fine grained materials such as silt and clay.

Soil type identifications and descriptions will be recorded by field samplers during field investigation activities. Soil types will determined when completing explorations (monitoring well installations, soil borings, and surface soil sampling) and other activities where descriptions of soils are needed to characterize site location conditions. These field descriptions may be supplemented with laboratory data on grain size distributions analyses to characterize soils.

2.0 EQUIPMENT AND SUPPLIES

- USCS Key
- 6 foot folding rule or other measuring tool
- PID
- Field Data Records
- Knife of spatula

3.0 PROCEDURE

Soil descriptions are made using the USCS Classifications and will include the following observations:

- Color
- Name
- Gradation
- Density
- Moisture

- Plasticity
- Structure
- geologic origin
- USCS classification designation.

A USCS key to soil descriptions and terms is included as Attachment 1. All sample descriptions will be recorded in a field log book and/or the Field Data Record for the media being sampled (see FSP Appendix C).

Attachment 1

USGC Classification Chart

KEY TO SOIL DESCRIPTIONS AND TERMS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, clean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations: (in this order)

Color (Munsell color chart)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Density/Consistency (from above, based on SPT "N" Value)
Moisture (dry, damp, moist, wet, saturated)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Geologic Origin (till, marine clay, alluvium, etc.)
Unified Soil Classification Designation

Sample Container Labeling Requirements:

Site:
Boring Number: Blow Counts:
Sample Number: Sample Recovery:
Sample Depth: Personnel Initials:

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Consistency is rated according to standard penetration resistance.

Descriptive Term (Modified Burmister System)	Portion of Total
trace	0% - 10%
little	10% - 20%
some	20% - 35%
adjective (e.g. sandy, clayey)	35% - 50%

Density of Cohesionless Soils	Standard Penetration Resistance N-Value (blows per foot)
Very loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.

Consistency of Cohesive soils	SPT N-Value blows per foot	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	0 - 2	0 - 250	Fist easily Penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	4 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	8 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	15 - 30	2000 - 4000	Indented by thumbnail
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

RQD = sum of the lengths of intact pieces of core* >100mm (0.3ft.) / length of core advance

*Minimum NQ rock core (1.88 in. OD of core)

Quality Description	RQD
Very Poor	<25%
Poor	25% - 50%
Fair	50% - 75%
Good	75% - 90%
Excellent	>90%

Desired Rock Observations: (in this order)

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Lithology (igneous, sedimentary, metamorphic, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
-dip (horiz - 0-5, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90)
-spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m)
-tightness (tight, open or healed)
-infilling (grain size, color, etc.)
Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and Rock Mass Description (very poor, poor, fair, etc.)
Recovery

MACTEC

MACTEC Engineering and Consulting, Inc.
511 Congress St. Portland Maine

SOP No. S-12

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

MONITORING WELL AND PIEZOMETER
INSTALLATION PROCEDURES

STANDARD OPERATING PROCEDURE

MONITORING WELL AND PIEZOMETER INSTALLATION PROCEDURE

1.0 SCOPE AND APPLICABILITY

This SOP describes how to install monitoring wells and piezometers in soil and bedrock borings.

2.0 EQUIPMENT AND MATERIALS

2.1 Required Equipment

- Field Sampling Plan
- Field Logbook Well Installation Field Data Record (See FSP Appendix B)
- Rule, engineers, 6 ft. folding
- Weighted fiberglass engineers tape (50 feet long minimum)
- PID
- Water level meter

2.2 Health and Safety Equipment

3.0 PROCEDURE

3.1 Selection of Interval

The placement of the well screen will be determined based on criteria identified in the project Work Plan and FSP.

3.2 Well Materials

3.2.1 Size

Select a diameter well that provides for an adequate sand pack in the borehole annulus.

3.2.2 Condition

Carefully inspect the condition of PVC pipe and screen for breaks, contamination, and non-conformance with project specifications. Verify that the required number and type of end plugs are available for the well.

3.3 Borehole

Flush the borehole to the desired depth (if drilling with casing below the water table) until the return is clear. For augers, verify that the bottom has not heaved prior to lowering the well.

3.4 Installation

Drillers should wear surgical type or other disposable gloves to avoid contaminating the well material with grease. The PVC should not contact the drill rig or other potentially contaminated equipment.

4.0 INSTALLATION

Installation of a typical, Schedule 40, 2-inch-diameter PVC well consists of a slotted section (0.010” machined slots) and a solid riser pipe, connected by flush-thread fittings. The annulus around the slotted section will typically be backfilled with Ottawa sand, and the riser backfilled with native material or bentonite-cement slurry. Bentonite seals and a surface cover complete the installation.

Project-specific requirements may require deviations from the typical installation described below.

4.1 Well Assembly

Assemble the bottom plug, desired length of screen, and solid riser. If the screen should straddle the groundwater table, leave sufficient screen for seasonal fluctuations.

4.2 Bottom Seal

Place bentonite chips or pellets to provide a minimum one-foot-thick seal at the bottom of the borehole.

4.3 Sand Pack

Lower the well into the borehole. As the casing or augers are slowly withdrawn, add Ottawa sand to the annulus. Measure frequently with a weighted tape or plunker, as care must be used to prevent bridging or sloughing of the formation if the drill stem is withdrawn too rapidly.

Bring the level of sand up to a minimum of one foot above the top of the screened section.

4.4 Upper Seal

Place a minimum one-foot-thick seal of bentonite pellets or chips above the top of the sand pack. If the borehole is to be sealed with a bentonite-cement slurry, the seal should be a minimum of two feet thick. If the seal is above the water table, hydrate the bentonite with clean water.

4.5 Backfill or Seal

Either backfill the riser with drill cuttings or prepare a bentonite-cement slurry and tremie it into the borehole, depending on the project's work plan. Formation materials or filter sand may be used above the bentonite seal to an approximate depth of 2 to 3 feet below the ground surface. A second bentonite seal will be placed at 2 to 3 feet below existing ground surface. The protective casing should be filled with filter sand from 6 inches below the protective casing to 2 inches below the top of the PVC. This allows water to drain out of the protective casing. In shallow wells, only one bentonite seal may be used.

4.6 Surface Casing

The casings may be road boxes or stand pipes. The well casing will be secured with a locking cap and a protective steel casing with a concrete surface seal. Stand pipes will be fitted with a locking cap. Road boxes should be set flush, with concrete sloped away from the well to limit runoff from entering the well. Label the casing with the well number.

4.7 Groundwater Monitoring Reference Mark

Cut the PVC riser and place a mark with indelible marker at the location to be surveyed for a groundwater elevation reference point. Allow the well to settle for a day, if possible, prior to surveying.

4.8 Well Development

Develop the well in accordance with SOP No. S-6 (See FSP Appendix B).

5.0 DECONTAMINATION

- Brush loose soil from equipment
- Rinse with tap or bottled water.
- Wash and brush with Liquinox™ (or equivalent) detergent wash.
- Rinse with tap or bottled water.
- If steam cleaning of down hole equipment is to be performed, document the effort in the logbook.
- Containerize and handle decontamination wastes and wastewater in accordance with applicable Federal, State, and local regulation.

6.0 REFERENCES

NEISOP-07 Soil Boring And Subsurface Soil And Bedrock Sampling Procedures

Site-specific Health and Safety Plan

ASTM D5092-90(95): Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

SOP No. S-13

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

FIELD PRESERVATION OF VOA AND VPH SOIL SAMPLES

STANDARD OPERATING PROCEDURE

FIELD PRESERVATION OF VOA AND VPH SOIL SAMPLES

1.0 SCOPE AND APPLICATION

This purpose of this standard operating procedure (SOP) is to outline the steps associated with field preservation of soil samples for volatile organic analysis (VOA) in accordance with U.S. Environmental Protection Agency (USEPA) Method 5035 (USEPA, 1996). This SOP includes procedures applicable to off-site laboratory Method 8260 and volatile petroleum hydrocarbon (VPH) (MassDEP, 2004) analyses specified in the Field Sampling Plan. Specific steps and details are described for the primary tasks of sample container preparation, soil sample collection, sample container management and documentation, sample analysis, and target compound quantitation.

2.0 SUMMARY OF METHOD

Soil and sediment samples will be preserved in water (low concentration) and methanol (high concentration) at the time of sample collection. Soils will be obtained from sampling devises (i.e., hand augers, split spoons or other auger sample collection apparatus, Geoprobe cores) using plastic syringe samplers used to reduce exposure of samples to air. Approximately 5 grams of soil for low concentration volatile organic compounds (VOC) and 10 grams of soil for high concentration VOC vials will be immediately transferred to a vial containing a pre-measured amount of preservation fluid. A soil mass of 10 grams will be added to vials for VPH analysis. Vials will be transported to the laboratory for analysis using procedures specified in the Quality Assurance Project Plan (QAPP).

- For low concentration VOCs, two vials will be collected at each location. Vials must be shipped to the laboratory each day or frozen within 48 hrs of collection. When freezing water preserved samples, vials should rest on their side to prevent glass from cracking during freezing.
- For VOCs and VPH, one high concentration methanol vial will be collected at each location.
- For locations selected for matrix spike analysis, the number of vials will be tripled (6 low and 3 high concentration vials).

3.0 EQUIPMENT AND SUPPLIES

- 40 milliliter (ml) glass VOA vial Teflon lined silicone septa lids filled with preservatives by the laboratory and pre-weighed.
- 20 ml plastic sampling syringe
- analytical balance capable of weighing to 0.1 gram
- utility knife
- stainless steel spatula
- vial storage cooler
- water resistant sample labels
- water proof marker
- Field Data Record (See FSP Appendix C)

4.0 PROCEDURES

4.1 Sample Container Preparation

Sample containers used for the collection of off-site VOA and VPH samples will be prepared in advance at the off-site laboratory. Container preparation by the off-site laboratory will include attaching labels, adding preservation fluid, weighing sample containers, and recording all information necessary to document container preparation and to calculate sample weight and target analyte concentrations during subsequent sample analyses. Developing and implementing the exact procedures for container preparation will be the responsibility of the contract laboratory. The following requirements are provided to the contract laboratory for incorporation into the off-site laboratory procedures:

1. Containers will be prepared for each VOA or VPH sample.
2. The sample container will consist of a wide mouth glass vial appropriate for VOA soil samples. The container must contain a Teflon lined cap with an air tight silicone or phenolic septa.
3. A water resistant sample label will be attached to each container. Each sample container will be assigned a unique sample container tracking number that is marked on the container label with permanent waterproof ink. The label will have room for field samplers to record sample identification (ID), date sampled, time sampled, and initials.
4. Low concentration VOA vials will contain a stirring bar and 5 mL of water. High concentration VOA sample containers will be filled with 10 ml of purge and trap grade methanol. VPH vials will be filled with 10 mL of methanol. The lot number of the methanol must be recorded. If possible, the laboratory will use a single methanol lot for the preparation of all VOA containers, or the laboratory should use as few lots as necessary for the program.

5. Sample container caps will be firmly capped to create an air-tight seal. Containers will be weighed and container weights will be recorded to the nearest 0.1 gram. No other tape or packaging material will be added to the containers. The laboratory will mark the approximate level of the methanol on the vial with a permanent marker. Containers will be stored in a designated location that does not contain other environmental samples or standards until shipment to the field. Containers will be shipped to the field office.
6. The laboratory will maintain container preparation records. Record keeping can be done using a bound notebook or preprinted forms. Records must contain all information necessary to document container preparation steps and calculate soil weights for each sample. These records will be submitted as laboratory notebook records with the analytical data deliverable packages. At a minimum the following information must be recorded:

   - preparation dates
   - container tracking number for each container
   - manufacturer and lot number of the containers
   - methanol supplier and lot number
   - pre-sampling weight of container and methanol (with cap and label on) recorded to the nearest 0.1 gram
   - signature or initials of the individual preparing the containers
   - additional fields for entering the post-sampling weight of container and the calculated weight of soil added to the container during sampling
   - signature or initials of individual recording and calculating final weights

7. Containers will be stored at the field office in a dedicated area away from samples of sources of contamination. After sample collection and shipment to the laboratory, containers will be re-weighed by the off-site laboratory sample manager and the weights will be recorded into the container preparation records for use in calculating the actual soil weights for each sample.
8. **A separate sample vial filled with soil will be submitted for percent moisture determination in association with each soil sample that is collected from a saturated location (sediment) or from any location where only a VOC or VPH sample is collected.** The moisture sample will be collected using the same technique as the preserved sample. The laboratory will homogenize the sample (without decanting standing water) prior to collecting an aliquot for moisture determination.
9. Samples will be analyzed in accordance with methanol extraction purge and trap procedures specified in the analytical method specified in the FSP or QAPP. **The laboratory will shake VOC high concentration and VPH samples as described in the referenced analytical methods prior to taking a methanol aliquot for analysis.**

4.2 SAMPLE COLLECTION

Sample collection will be performed with a disposable plastic syringe. The appropriate volume of soil collected in the syringe will be estimated prior to sampling to collect the appropriate weight of soil specified in Section 2.0. Field personnel will make note of preservation fluid levels on the sample containers to ensure no significant loss had occurred. Field personnel are responsible for ensuring that sample containers remain on ice at all times. The specific steps and details for soil sample collection are outlined below:

1. Using a clean utility knife or other sharp knife carefully cut of the tapered end of the 20 ml plastic sampling syringes. Take care to remove the tapered portion without removing significant portions of the body or tube of the syringe. Sampling syringes are disposable and are not to be reused after collecting a sample.

2. Transport sample containers in cooler with bagged ice. Keep sample containers in individual zip lock bags.

3. Obtain photoionization detector (PID) readings from the sample surface.

4. Samples are collected by capturing a representative sample within the sampling syringe and transferring the soil to the VOA vial. **For low concentration VOCs, two vials will be collected at each location. For VOCs and VPH, one high concentration methanol vial will be collected at each location (see method summary).** If samples are collected using split spoons or a Geoprobe sampler, samples will be collected from the soil core immediately upon opening the sampling devise. If samples are collected from hand augers samples will be collected from within the auger core. For surficial sediments or test pits, samples will be collected directly from the sampling location substrate. Push/advance the sampling syringe into the center of the sample core/location filling the soil sampling syringe to the target level volume. Pull the syringe plunger back further to apply suction on the soil sample which will help it to remain in the syringe during removal. Separate the syringe sample from the remaining soil. Remove the syringe. If the proper volume of soil is not present, repeat the procedure until the proper volume of soil has been collected. If necessary, use a stainless steel spatula to fill the syringe with the needed soil volume. If rocks are present in the sample it may be necessary to extrude the sample from the sleeve, select a portion of the core sample that is void of large rocks, and then advance the sampling syringe. If possible, the sample volume should consist of sand, silt or clay and contain very few rocks or pebbles.

   Note: If matrix spike/matrix spike duplicate (MS/MSD) samples are required, additional sample volume is necessary. Low Level Concentrations require 2 vials of DI water and 1 vial of Methanol. Methanol is used to screen the sample. These screening results are interpreted and the appropriate analysis is performed.

5. Remove a sample container from the cooler. Carefully extrude the soil sample from the syringe into the sample container. This task should be done slowly and carefully to insure that the preservation fluid does not splash from the sample container. **A second vial used for moisture determination will be collected for all soils collected below standing water or at any location where only VOC samples are collected. The samples will be collected using the same sample syringe and coring technique used for the actual field sample. The sample jars will be labeled "percent moisture determination for VOA" with the sample label also containing all other sample information including sample ID, date and time sampled, and sampler initials.** The laboratories will be instructed to homogenize the VOA percent moisture sample in the jar prior to removing an aliquot for moisture determination to simulate actual sample moisture added to the methanol vials.

6. Syringes should be discarded immediately after extruding sample from syringe; do not reuse. If split samples are collected, care must be taken to make the samples equally representative (i.e., collected from the same part of the soil core).
7. Replace container cap as soon as possible.
8. With permanent waterproof ink fill out the sample container label with the following information: date, time, location, depth of sample, sample ID code, sample type (i.e., regular, duplicate, matrix spike, matrix spike duplicate), and sampler initials. The approximate level of the methanol will be marked on the sample vial. Do not tape over the sample container label.
9. Make sure the sample container lid is screwed down tightly. If necessary wipe excess soil from the mouth of the container to get an air-tight seal. Place the sample container back into the zip lock bag. Place the container and bag into the cooler taking care that the sample container remains upright. Keep samples on ice until they are submitted to the sample manager.
10. Complete the appropriate Field Data Record (See FSP Appendix B) and release the samples to the sample manager.

5.0 SAMPLE MANAGEMENT

Upon completion of sample collection, sample containers will be released to a sample manager. The specific steps and details for sample management are outlined below for samples submitted to the off-site laboratory.

5.1 Off-Site Laboratory Samples

Sample containers will be weighed by the off-site laboratory sample manager immediately upon receipt at the off-site laboratory. The sample manager will record the container identification number and post-sampling container weight on the chain of custody. A trip blank will accompany each shipment of samples to the off-site laboratory. The trip blank will consist of a sample container containing water (low concentration) and one containing methanol (high concentration) prepared by the off-site laboratory for the same analytical method as the field samples.

6.0 REFERENCES

Massachusetts Department of Environmental Protection (MassDEP), May, 2004. “Method for the Determination of Volatile Petroleum Hydrocarbons (VPH)”; Division of Environmental Analysis; Office of Research and Standards; Bureau of Waste Site Cleanup; Revision 1.1.

U.S. Environmental Protection Agency (USEPA), December, 1996. "Test Methods for Evaluating Solid Waste"; Laboratory Manual Physical/Chemical Methods; Office of Solid Waste and Emergency Response; Washington, DC; SW-846; November 1986; Revision 4.

SOP No. S-14

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

SOIL HEADSPACE SCREENING PROCEDURE

STANDARD OPERATING PROCEDURE

SOIL HEADSPACE SCREENING PROCEDURE

1.0 SCOPE AND APPLICABILITY

A. PURPOSE

To screen soil sample headspaces for total ionizable volatile organic compounds (VOCs). This is a semi-quantitative method used to identify the presences, absence, and relative concentrations of VOCs in soil. Headspace screening is performed with a photoionization detector (PID) or, less commonly, a flame ionization detector (FID)[1]. Screening may used to:

1. Segregate soil piles;
2. Identify soil samples for laboratory analyses; and
3. Provide a qualitative assessment of the presence of VOCs for use in contamination assessments.

2.0 SUMMARY OF METHOD

A sample of soil is placed in a plastic bag or sample jar and sealed. The sample is shaken and held to allow VOCs to fill the air space. The air is tested for VOCs using a hand held detector.

3.0 HEALTH AND SAFETY WARNINGS

The project Health and Safety Plan should be reviewed to determine the level of personal protection is required for work at site locations.

4.0 INTERFERENCES AND LIMITATIONS

4.1 To be detected, compounds must be present, volatile <u>in the state of the soil sample being screened</u>, and capable of being ionized by the PID or FID detector in use.

4.2 Screening results will vary based on sample temperature, compounds present, age of the sample, and the degree to which the sample has been agitated and crumbled.

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[1] The SOP will refer to PID, for which FID may be substituted unless noted.

4.3 VOCs in soil gas or groundwater within the soil pores will produce positive screening results even for soil samples which may not "contain" VOCs.

4.4 Water vapor may cause large-scale zero drift in the PID.

5.0 MATERIALS

5.1 Screening

- PID, including calibration kit and manual
- Sample jars or plastic bags
- Indelible marker
- Aluminum foil

5.2 Recording

- Field logbook
- Field Data Record if applicable (See FSP Appendix C)

5.3 Health and Safety Equipment per Work Plan

6.0 PREPARATION

6.1 Calibrate PID per manufacturer's instructions and document calibration in the field book. Make note of calibration or spanning to non-standard specifications.

6.2 Refer to NEISOP-07 for soil sample collection procedures.

7.0 PROCEDURES

7.1 Record and document background VOC readings in ambient air. If it is not feasible to screen samples in an area with a clean background, document the highest background reading.

7.2 Half fill a clean jar or Ziplock™ type plastic bag with soil. Quickly cover the jar with aluminum foil or close the plastic bag and label the container.

7.3 Vigorously shake the sample to disperse soil and wait for approximately 5 minutes. Record the ambient temperature at which screening is performed. If outside temperatures are below 50°F, try to warm the samples in a heated vehicle or building.

7.4 Shake the sample again after 5 minutes.

7.5 Insert the tip of the PID through the foil or into the plastic bag and record the highest meter response, typically after approximately 3 to 15 seconds.

7.6 After screening all samples, re-check background and record significant variations.

8.0 REPORTING

The PID has a reliable reporting limit of 1 part per million in air. Readings at or below the reporting limit should be reported as “ND,” “BDL,” or similar terminology.

9.0 DECONTAMINATION

- Brush loose soil from the PID, etc.
- Containerize and handle decontamination wastes and wastewater in accordance with the Site Management Plan and FSP.

SOP N0. S-15

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

SPILT-SPOON/SPLIT-BARREL SUBSURFACE SOIL SAMPLE COLLECTION AND STANDARD PENETRATION TEST PROCEDURE

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STANDARD OPERATING PROCEDURE

SPILT-SPOON/SPLIT-BARREL SUBSURFACE SOIL SAMPLE COLLECTION AND STANDARD PENETRATION TEST PROCEDURE

1.0 SCOPE AND APPLICATION

1.1 This Standard Operating Procedure (SOP) is applicable to the collection of representative subsurface soil samples utilizing a split-spoon or split-barrel (split-spoon) sampler. In addition, this SOP provides the procedure for implementing the Standard Penetration Test (SPT). The results of an SPT yield a practical value of relative bearing capacity. The SOP is applicable for civil, environmental, and geotechnical investigations.

2.0 SUMMARY OF METHOD

2.1 The use of a split-spoon sampler provides either continuous or discrete collection of soil samples from the subsurface. In addition, the use of the sampler is an iatrical component of the SPT. The split spoon sampler is typically utilized in conjunction with conventional drilling techniques such as hollow stem auger or drive-and-wash drilling.

2.2 The assembled split-spoon sampler is hammer- or weight-driven into the soil such that a hollow core of the sampler is filled with soil and withdrawn from the boring. Once withdrawn from the boring, the split-spoon sampler is disassembled and the resulting sample is exposed for collection, field analysis(es), and/or classification.

2.3 The SPT is a test that results in a relative soil bearing capacity based upon the number of times the hammer or weight (of known mass and fall distance) drives the split-spoon two feet into the soil (aka. the “blow count”).

2.4 Soil samples are collected for classification of lithology, field headspace screening (in the case of petroleum/chemical release investigations), and laboratory analysis (geotechnical and/or environmental in nature).

3.0 DEFINITIONS

3.1 Split-Spoon Sampler - open-ended cylindrical tool used to collect samples by driving or pushing them into the ground. Split-spoon samplers have inside diameters ranging from 3 to 6.3 cm (1-3/8 to 2-1/2 in.) and usually consist of five parts, similar to a continuous barrel sampler (Figure 1).

4.0 HEALTH AND SAFETY WARNINGS

4.1 This SOP does not address specific activity hazard analyses inherent with this procedure, and cannot address all hazards associated with drilling activities. Therefore, health and safety details such as activity hazard analyses should be included and referenced in Site Specific Health and Safety Plan. The following is a highlighted summary of health and safety issues associated with every split-spoon sampling event.

4.2 Prior to the advancement or **ANY** subsurface activity (e.g., drilling, excavation, etc.), calls to the appropriate underground utility clearance organizations such as DIGSAFE and municipal utility departments **MUST** be made, and utility clearance **MUST** be received. Records of this call should be available to field staff.

4.3 Split-spoon sampling involves the use of many moving parts, each of which may present a pinching hazard, overhead weights which may present crushing hazards, and sharp objects and hand tools which may present piercing, crushing, or repetitive motion hazards. In addition, driving the split-spoon with the weights/hammers may present a noise hazard.

4.4 Often, split-spoon sampling is involved in the investigation or remediation of a petroleum or hazardous material release. Particular chemical-specific hazards (which are detailed in the site health and safety plan) are present and specific safety parameters/controls are required.

5.0 CAUTIONS

5.1 If the potential for subsurface contamination exists at a location or is unexpectedly encountered during drilling, care should be used to prevent penetration of any geologic confining layer, which may impact the distribution of contamination. Thin confining layers may not be readily identified if non-continuous sampling is utilized.

5.2 Split-spoon sampler damage may result from overdriving the sample, or if the sampler is driven into rock. Split-spoon sampling is generally not feasible in weathered rock.

5.3 Split-spoon sampling is generally more-difficult if a “running-sands” condition is encountered. Often, this condition can be accommodated using a drive and wash drilling method as opposed to a rotary auger method.

6.0 INTERFERENCES

6.1 If a split-spoon sample is collected from a cohesionless and unconsolidated aquifer, the groundwater in the formation may run out of the sampler once above the water table causing the fine-grained materials to “wash out” from the sample. If observed, this condition should be noted in field logs.

6.2 If soil samples are to be collected for volatile organic compounds (VOC) analysis (including field headspace screening), samples should be collected immediately upon separating the two halves of the sampler. SOPs for field headspace screening and preservation of soil samples for VOC analysis have been developed under separate cover. A delay in collection of VOC samples may result in an underestimation of VOC concentrations in the affected sample(s).

6.3 During environmental investigations, insufficient homogenization of the non-volatile sample aliquots may result in a faulty estimation of contaminant concentrations.

7.0 PERSONNEL QUALIFICATIONS

7.1 Soil samplers utilizing this SOP should be familiar with the methods of drilling which coincide with the split-spoon sample collection technique.

7.2 Soil samplers utilizing this SOP should be proficient in visually-classifying soil samples via the MACTEC Engineering and Consulting, Inc. SOP for Description and Identification of Soils.

7.3 In the case of petroleum/chemical release investigations, personnel should be trained to the appropriate degree in hazardous waste site safety procedures as per OSHA regulations.

7.4 Any drill operators should be qualified to operate the drill and be licensed (if applicable) in the State in which the work is being performed. Drill operators should also be trained in hazardous waste site safety procedures as per OSHA regulations as needed.

8.0 EQUIPMENT AND SUPPLIES

8.1 The following list is not exhaustive, but provides a listing of "at a minimum" equipment and supplies.

8.2 For all subsurface sampling events the following equipment is required:

- Drill equipment; Hollow Stem Auger rig, Barber drill rig, Air/Mud Rotary rig, etc.
- Split spoon samplers and drill rods
- Field logbook
- Stakes, pin flags, or other marker
- Folding engineer's rule
- Lumber crayon
- Labeled sample jars (for classification)
- Indelible marker
- Fiberglass engineer's tape measure
- Decontamination equipment
- Camera

8.3 For environmental investigations, the following equipment should be included:

- Stainless-steel bowl and mixing scoop/spoon
- Environmental sample containers

- Coolers
- Ice
- Chain of custody forms
- Appropriate personal protection equipment (ppe)

8.4 Additional optional equipment may include:

- Field penetrometer
- Field torvane
- Field gradational sieves

9.0 PROCEDURES

9.1 After the soil boring has been advanced to the desired sample depth and cuttings have been removed from the hole, the following procedure shall be followed for the collection of a representative subsurface soil sample. (*Paraphrased from ASTM D 1586.)*

9.1.1 Attach the split spoon to the drill rods and lower into the open bore hole. Do not allow the sampler to drop to the bottom of the boring.

9.1.2 Position the hammer/weight above the drill rods and attach the anvil to the top of the rod string.

9.1.3 Rest the entire weight of the rod string, anvil, and hammer on the sampler to determine the approximate amount of bore hole slough is present. Remove if needed.

9.1.4 Mark the drill rods in 6-inch increments over two feet, such that the advance of the sampler is easily observed over each 6-inch increment.

9.1.5 Drive the sampler with blows from the 140-lb hammer, and record the number of blows per 6-inch increment over the 2-foot sample span. Continue driving the sampler until 1: a total of 100 blows have been applied, 2: there is no observable advance of the hammer over 10 consecutive blows, or 3: the sampler is advanced the entire 24-inch length of the sample span.

9.1.6 The sum of the 6”-12” and 12”-18” penetration is termed the “N-value” and should be recorded.

9.1.7 Bring the sampler to the surface using the drill rod and drill derrick. Open the sampler and record total recovery in tenth's of an foot, and place a representative sample in a jar for classification (and in the case of petroleum/chemical release investigations also for headspace screening via MACTEC Engineering and Consulting, Inc. SOP for Soil Sample Headspace Screening for VOCs).

9.1.8 If applicable, immediately upon opening and determining the appropriate sample collection depth, the VOC sample should be collected and directly transferred to the appropriate sample container and immediately preserved in accordance with MACTEC Engineering and Consulting, Inc. SOP for Soil Sample VOC Preservation.

9.1.9 If environmental laboratory analytical samples are to be collected, the remaining split-spoon sample volume (after the VOC sample aliquot has been collected) shall be placed in a dedicated or decontaminated stainless-steel bowl and homogenized with a dedicated or decontaminated stainless-steel scoop/spoon for approximately 30 seconds to ensure sample homogeneity. A sample of the homogenized soil will then be collected and transferred to the appropriate soil sample containers. The number, type, and size of the individual sample containers will vary depending on analysis to be performed, and should be detailed in the approved site sampling and analysis plan or similar approved planning document.

9.1.10 If no environmental laboratory analytical samples are to be collected, the remaining split-spoon sample volume should be discarded or disposed of in an appropriate fashion with soil boring cuttings generated during the advancement of that specific boring.

9.1.11 After completion of sample collection, all sampling equipment should then be decontaminated in accordance with the approved sampling and analysis plan or other similar approved planning document.

9.1.12 All Investigation Derived Waste (IDW) shall be handled and disposed of in accordance with an approved sampling and analysis plan or other similar approved planning document.

10.0 DATA AND RECORDS MANAGEMENT

10.1 A record of conversation relative to utility clearance will be included in the project file.

10.2 A record of the visual classification of each sample will be retained in the project file in either field-logbook for or on a dedicated soil boring log.

10.3 If applicable, the sample classification jar should be retained until such time as it may be discarded. This may vary with contract/project requirements.

10.4 A photograph of a typical sample setup should be included in the project file as documentation that this SOP was followed adequately.

11.0 QUALITY CONTROL AND QUALITY ASSURANCE

11.1 Quality control and quality assurance parameters for sample collection vary from project to project, therefore, no procedures are set forth in this SOP. It should be noted that project sampling and analysis plans, quality control plan, or other similar planning document typically provide detailed information regarding QA/QC sample collection frequencies/schedules, and also decontamination procedures and verification sample collection, in particular as it applies to a petroleum/chemical release investigation.

12.0 REFERENCES

12.1 References cited as applicable to this SOP:

- *ASTM Designation D 1586-84 (Reapproved in 1992); Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*
- *ASTM Designation D 2487-93; Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)*
- *U.S. Environmental Protection Agency EPA/240/B-01/004; Guidance for Preparing Standard Operating Procedures (SOPs), March 2001*

12.2 Cross-Referenced SOPs:

- *MACTEC Engineering and Consulting, Inc. SOP No. S-11 for Description and Identification of Soils*
- *MACTEC Engineering and Consulting, Inc. SOP No. S-13 for Field Preservation of Volatile Organic Compounds (VOC) Soil Samples*
- *MACTEC Engineering and Consulting, Inc. SOP No. S-14 for Soil Sample Headspace Screening for VOCs*

13.0 FIGURES AND ATTACHMENTS

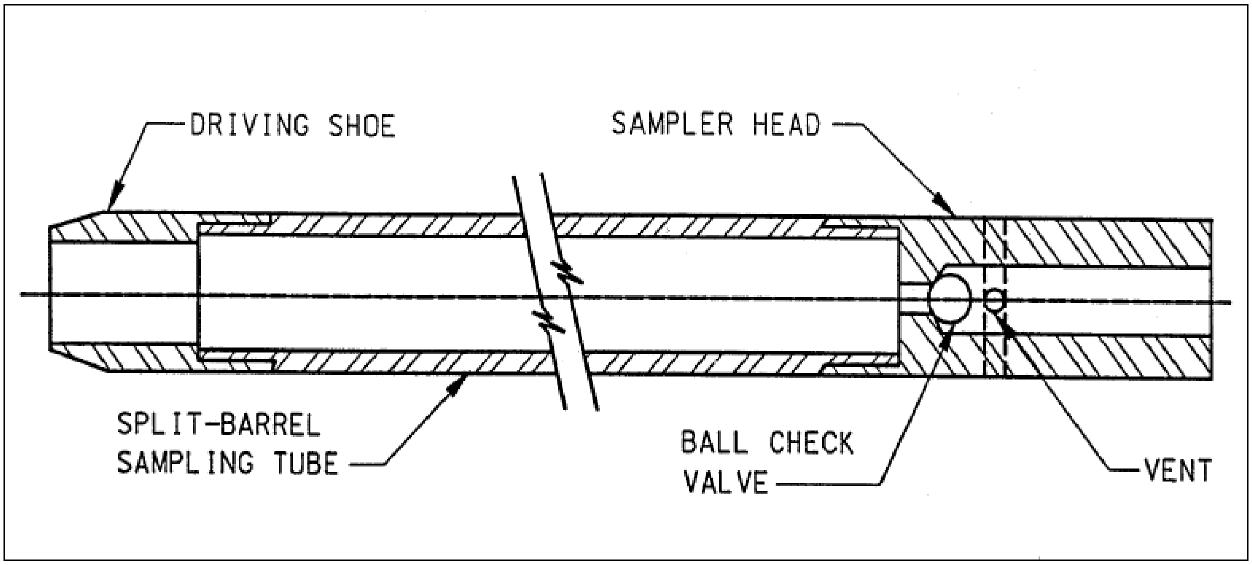


Figure 1. Schematic of a Split Spoon Sampler

SOP No. S-16

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

GEOPROBE DIRECT PUSH SAMPLING

STANDARD OPERATING PROCEDURE

GEOPROBE DIRECT PUSH SAMPLING

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes methodologies using a GeoProbe® direct-push sampling system that may be used to conduct soil, groundwater, or soil vapor sampling surveys. This technology can be used to collect samples for off-site laboratory analysis or provide screening information that can be used to optimize the future location of soil borings and monitoring well installations and to assess contamination in the vadose zone and saturated overburden. The project objectives and data quality objectives (DQOs) for the GeoProbe® sampling will be described in the project-specific Work Plans.

The direct-push explorations shall be completed by a qualified direct-push subcontractor, and directed by a qualified field person.

2.0 SUMMARY OF METHOD

Direct-Push drilling technique consist of a hydraulic ram unit, usually mounted on a small vehicle (ATV, cargo van, or pick-up truck) that advances small diameter drill rods to obtain overburden soil or groundwater samples or install piezometers. The Geoprobe® pushes and/or hammers rods and probe tips into the subsurface for sample collection. Advantages in environmental investigations include low cost, maneuverability and access to irregular terrain, minimization of investigation derived wastes. Disadvantages include depth limitations and small sample volumes.

The direct push device may employ either dual tube methodology which allows the collection of subsurface soil samples through an outer casing that is set to maintain the integrity of the boring or single-rod method that collects soil into a sleeve liner within the lead rod.

In the dual-tube method borings are advanced by simultaneously driving an outer stainless steel casing and inner Lexan® tube into the ground. Upon reaching the desired penetration depth, the inner Lexan® tube is extracted to collect the discrete subsurface soil samples, leaving the outer casing in place. To sample the next interval of soil, a new length of Lexan® tubing is then inserted into the outer casing (already in the ground) attached to a length of drive pipe, and another length of outer casing is attached to the top of the outer casing that is already in the ground.

In the single-rod method, ¾-inch diameter rods are advanced in 4-ft sections. The lead section is fitted with an inner acetate sleeve. When the top of the desired sampling interval is reached, a tool is used to unlock the drive point and the rod is driven ahead to obtain the soil sample. The entire drill rod is retrieved and the liner removed for characterization. The process is then repeated to collect the next desired sample.

This process may be modified to collect groundwater samples or soil gas samples as described in the groundwater and soil vapor procedures.

3.0 DEFINITIONS

4.0 HEALTH AND SAFETY WARNINGS

As with any heavy equipment, caution should be taken to minimize the potential for injuries such as crushing and pinching. Additionally, the drill rig has overhead hazards and in most cases noise hazards which should also be considered. Before any drilling is completed, the rig should be set level and the operator should inspect the location to verify that the unit is stable and secure enough to operate.

All personnel shall be familiar with the location of the rig's emergency kill switch.

All non-essential personnel should be kept clear of exclusion zone or from an area surrounding the rig.

Due to the potential of noise, ear protection is required. If needed, hand signals should be developed for communication between engineer and the driller.

5.0 PERSONNEL QUALIFICATIONS

The GeoProbe® operator should be familiar with the rig operations to adequately perform the sample collection task. The rig geologist/engineer should be sufficiently skilled in the drilling method and also be proficient in the classification of soils.

6.0 EQUIPMENT AND SUPPLIES

The following materials will be available, as required, during the subsurface soil sampling:

- Health and safety equipment;
- Direct push sampling equipment;
- decontamination equipment as specified in the QAPP;
- Stainless steel trowels or spatulas;
- Aluminum Foil;
- Paper Towels;
- Measuring device;
- Appropriate sample containers and Field Data Records (see Field Sampling Plan [FSP] Appendix C)
- PID;
- Acetate field knife (if liner sleeves are used to collect the soil samples);
- Field notebook.
- Appropriate decontamination equipment (steam cleaner, materials for a decon pad, etc.) as necessary
- Drums for IDW containment as specified in the work plans
- PPE and monitoring equipment as specified in the Health and Safety Plan
- Piezometer construction materials if specified in the FSP.

7.0 PROCEDURES

Procedures are presented for soil sampling, groundwater sampling, and soil vapor sampling. Only procedures and media sampling specified in the project FSP will be completed. The operator should consult the FSP and field operation leader prior to completing investigation work.

7.1 Geoprobe® Soil Sampling

The following procedures will be employed to collect subsurface soil samples:

1. Identify sample locations from the Work and note the locations in field notebook by obtaining ties to physical features.
2. Obtain and wear the appropriate PPE.

3. Set up an equipment cleaning station, and decontaminate equipment as described in the FSP. Use new, clean materials when decontamination is not appropriate (e.g., disposable gloves and dedicated drive points). Document the decontamination procedure in the field notebook.

4. Assemble the appropriate direct-push sampling apparatus or other direct push tool. Soil samples will be collected using a three or four-foot long 1-to-2 inch diameter core sampler. The FSP will determine if a dual tube split-spoon system or an single rod acrylic liner method will be used for the collection of subsurface soil samples.

5. Drive the sampling tools to the appropriate sampling zone and collect a sample base on the type of direct-push method being used. Open the sampler by unscrewing the cutting shoe and retrieve the rod containing the soil sample. Open the sampler and cut open the acetate liner if used. Screen for VOCs using the PID. Collect the needed soils for laboratory analysis per requirements of the FSP. Measure and describe the sample lithology on the Soil Boring Log Field Data Record (See FSP Appendix C) using the USCS Procedures for Description and Identification of Soils SOP S-11 (See FSP Appendix B).

6. Evaluate the sample for the presence of visible non-aqueous phase liquid (NAPL). Document samples interpreted to contain visible NAPL, and record observations in field notebook and boring log.

7. Decontaminate non-disposable equipment or tools that may have come into contact with subsurface soil in accordance with the FSP.

8. Discard all disposable equipment used during sampling activities in a designated location.

9. Record sample collection information in the field notebook or Soil Boring Field Data Record including sample location, depth, PID readings, and analytical fractions collected.

10. Identify the next sequential boring location, move to that location and return to step 2.

Records of each exploration shall be made on a Soil Boring Log (See FSP Appendix C) and in the field logbook. All cuttings or other waste will be containerized or disposed of in accordance with planning documents.

7.2 GeoProbe® Groundwater Sampling

A direct-push sampling system (e.g., Geoprobe® or equivalent) may be used to obtain discrete groundwater grab samples if specified in the FSP. The collection of groundwater grab samples via the direct-push method is dependent on sufficient saturated thickness of overburden soils and an adequate rate of inflow through the probe tip.

1. A direct-push system advances a steel probe assembly to the desired depth indicated in the FSP as described in Section 7.1.
2. Groundwater samples are collected by allowing formation water to flow into a slotted probe tip or wire rapped stainless steel screen. Water within the probe is purged and sampled from inside the rod assembly using small-diameter tubing and a low-flow rate sampling pump, or a small-diameter bailer. One tubing volume of water will be purged and one set of parameters including temperature, conductivity, pH, and turbidity will be collected before sampling. VOC samples will be collected at a low purge rate (approximately 100 milliliters per minute) to minimize potential volatilization.
3. Sequential (vertical profile) sampling may be performed by driving the probe assembly to a predetermined depth and collecting a sample. Following sample collection, an additional section of riser is connected, and the sampling device is driven to the next sampling interval, where another sample is collected. Non-dedicated pumps and tubing shall be decontaminated and dedicated tubing shall be discarded between sample collection intervals.
4. Groundwater sample collection data shall be recorded on the Conventional Groundwater Sampling Field Data Record (See FSP Appendix C) and in the field logbook.

7.3 Geoprobe® Soil Vapor Sampling

Soil vapor samples may be collected using a GeoProbe® sampling device to provide data on the presence of VOCs in the subsurface vadose zone. Field data and observations will be recorded on the Geoprobe Soil Vapor Sampling Record (Figure 4.11). Samples may be analyzed at an off-site laboratory or with an on-site instrument.

The Geoprobe® rods will be pushed to the desired sampling depth (expected to be below the rain infiltration line, but above the water table fringe zone).

<u>Procedure for GeoProbe® Soil Vapor Sample Collection in Summa Canisters</u>

Soil vapor samples will be collected from the Geoprobe® points using either the Geoprobe® PRT system, or through open Geoprobe® rods.

1a. To sample through the open rods, the rods are pushed down to the target depth and then pulled back slightly, allowing a disposable point to drop off the bottom and expose the bottom of the open (hollow) rods to the soil. The rods will be sealed with O-rings at the joints and have a 1/4-inch tubing attached to the top for vapor purging and sample collection.

1b. To sample with the Geoprobe® PRT system, a specialized point is attached to the end of the Geoprobe® rods. The PRT point is also exposed to the soil by allowing a disposable tip to drop off the bottom of the rods when the rods are backed out slightly. This PRT point allows a ¼-inch tubing to be threaded directly to the bottom of the rods, for a small discrete sample point. The tubing is run to the surface and connected directly to the sample collection device.

2. For both techniques the outside of the rods will be sealed at the ground surface with pre-hydrated bentonite. Approximately 1 liter of soil vapor, plus the volume of the tubing or rods, will be purged using a personal air monitoring pump before collecting samples. During the soil vapor purge, vapors will be screened with a PID.

3. Soil vapor samples will be collected with either 1.4-liter SUMMA®-type canisters with flow valves (set to approximately 20 minutes per sample), or with Tedlar bags (Tedlar bags may be filled using either a Vac-U-Chamber®, or with a syringe with a three way valve).

SUMMA® canister sample collection

- Place SUMMA® canister adjacent to the temporary sampling port.
- Record SUMMA® canister serial number on sampling summary form and COC.
- Record sample identification on canister identification tag, and record on sampling summary form and COC.
- Remove plastic cap canister fitting.
- Open and close canister valve.
- Record gauge pressure on sample summary form and COC. Gauge pressure must read >25 inches Mercury (Hg). Replace SUMMA® canister if gauge pressure reads <25 inches Hg.
- Connect canister to silastic tubing already connected to the subsurface probe.
- Open canister valve and in-line stainless steel valve to initiate sample collection.
- Record date and local time (20-minute basis) of valve opening on sampling summary form and COC.
- Take digital photograph of SUMMA® canister and surrounding area.
- Upon completion of 20 minute sample collection, record gauge pressure on sampling form and COC.
- Record date and local time (20 minute basis) of valve closing on sampling form and COC.
- Close canister valve.
- Disconnect silastic tubing and recap pressure gauge.
- Remove SUMMA® canister from sample collection area.
- Remove temporary probe from hole. Fill hole with a quick drying hydraulic cement.

Tedlar bag sample collection using Vac-U-Chamber®

1. The sampling line will be connected to a Vac-U-Chamber® Tedlar bag sampling box containing a one liter Tedlar sample bag.
2. The external pump is then connected to the purge port and the soil vapor sampling probe will be purged for two minutes prior to sample collection.
3. After purging the system, the external pump is connected to the vacuum port and the Tedlar bag is allowed to inflate. Upon complete inflation of the Tedlar bag, as observed through the Vac-U-Chamber® viewing window, the Tedlar bag valve is closed and the sample is labeled with the unique sampling location identification code.
4. If duplicate samples are collected, the duplicate sample will be collected by inserting a tee connector in the sampling line and filling two Tedlar bags from one probe at the same time.

Tedlar bag sample collection using syringe with a three way valve

1. The sampling line will be connected to the bottom port of a three way valve system.
2. A 60 to 100 milliliter (ml) syringe is then connected to the top purge port. The sampling line valve and the purge port are opened and the syringe is filled.
3. The sampling line valve is then closed and the side port is opened. The syringe is this emptied and the side port is closed.
4. A one liter Tedlar sample bag is connected to the three way valve side port. The sampling line valve and the purge port are opened and the syringe is filled again. The sampling line valve is then closed and the side port is opened. The contents of the syringe are then purged into the Tedlar bag. This process is continued until the Tedlar bag has been filled.

8.0 QUALITY CONTROL

For soil vapor events, helium leak tests will be conducted on a subset of samples to ensure samples are representative of sub-surface conditions and not outdoor ambient air. Helium leak tests will be conducted by encapsulating the sample point (such as with a bucket sealed to the ground surface with bentonite), while allowing the tubing to be purged from outside the encapsulated area. The encapsulated area will be filled with helium, but care will be taken not to pressurize the enclosure. The soil vapor sample port will be tested for helium breakthrough with a portable monitoring device (such as the Radio detection MGD-2002 Multi-Gas Locator) both before and after collection of the soil vapor sample. If greater than 10 percent of the tracer gas is detected in the screening sample, the sample point seal will be enhanced and the procedure repeated.

9.0 DATA AND RECORDS MANAGEMENT

The following records will be generated by the site geologist or field sampler:

- Field Logbook entry
- Soil Boring Log Field Data Record (See FSP Appendix C)
- Conventional Groundwater Sampling Field Data Record (See FSP Appendix C)
- Geoprobe Soil Vapor Sampling Record (See FSP Appendix C)

SOP No. S-17

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

CALIBRATION PROCEDURE FOR PID

STANDARD OPERATING PROCEDURE

CALIBRATION PROCEDURE FOR PID

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes methodologies for calibration of the hand held photoionization detector (PID) used for field monitoring during sampling events. This procedures is designed to be used in conjunction with the instrument manufacturer instructions provided as Attachment 1 of this SOP.

2.0 SUMMARY OF METHOD

Calibration is completed by analyzing a clean zero air sample and a sample of span gas (isobutylene) of know concentration. The instrument software is used to set the PID response.

3.0 DEFINITIONS

4.0 HEALTH AND SAFETY WARNINGS

Care should be taken when handling gas cylinders.

5.0 INTERFERENCES

The PID will respond to a variety of compounds that may be present as background in the ambient air. Testing of air at background locations or up wind locations may be necessary to understand the baseline response at a given site location.

Compound identification is not possible.

6.0 EQUIPMENT AND SUPPLIES

- Photoionization detector
- Zero gas cylinder
- Span gas cylinder
- Field Instrument Calibration Record (See FSP Appendix B)
- Field logbook

7.0 PROCEDURES

Procedures are specified in the instrument manufacturers instructions contained in Attachment 1 to this SOP.

8.0 DATA AND RECORDS MANAGEMENT

Instrument calibration should be documented on a Field Instrument Calibration Record and in the field logbook.

9.0 QUALITY CONTROL/QUALITY ASSURANCE

No additional procedures are required.

ATTACHMENT 1

PID INSTRUCTION MANUAL

MODEL 580B

ORGANIC VAPOR METER (OVM) / DATALOGGER

INSTRUCTION MANUAL
P/N 16860

TE *Thermo Environmental Instruments, Inc.* MODEL 580B

CLASSIFIED BY
UNDERWRITERS LABORATORIES, INC.®
AS TO ELECTRICAL SHOCK AND
EXPLOSION HAZARD ONLY 700D
FOR USE IN: CLASS I, DIVISION 2
GROUPS A,B,C & D
HAZARDOUS LOCATIONS

CLASSIFIED UL C CLASSIFIED UL

S/N 580U-

THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS (AS APPLICABLE) OR NON-HAZARDOUS LOCATIONS ONLY.

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

THERMO ENVIRONMENTAL INSTRUMENTS INC.
8 WEST FORGE PARKWAY
FRANKLIN, MASSACHUSETTS 02038

TELEPHONE: (508) 520-0430
FACSIMILE: (508) 520-1460

1-9-96

4.4 580B CALIBRATION

The following procedure is applicable for both Cylinder and Bag Standards. The sequence requires both Zero gas and Span gas to be used. Span gas can be either contained as a cylinder or bag, in either case the exact concentration used must be known. This concentration will be entered to the 580 when the program provides its entry. With respect to Zero gas, there are several choices. Obviously a certified zero air standard in a cylinder presents no problem. Another choice would be to build a zero air standard in a bag. This can be simply accomplished with the set-up in Figures 4.1 and 4.2 using a charcoal scrubber to remove all the hydrocarbons present in the air. Charcoal does not absorb Methane; this does not cause a problem because the PID does not respond to it. Another approach which could be used in an emergency is to use room air unscrubbed.

This is acceptable if you know that there are no hydrocarbons present or they are exceptionally low in concentration. However, it is not recommended as a standard practice. The physical set up for cylinder calibration is illustrated in Figure 4.1; bag calibration in Figure 4.2.

4.4.1 CALIBRATION ROUTINE

(A) Set-up calibration assembly with zero air cylinder or bag as described in Figures 4.1 and 4.2.
(B) Model 580B set-up and zero calibration.

1. Power-up instrument using power plug.
2. Depress ON/OFF Key to ignite lamp and initiate sample pump.
3. Depress MODE/STORE Key.
4. Depress-/CRSR Key in response to LOG THIS VALUE? Prompt.
5. Depress-/CRSR Key to select Parameters Mode from the Main Menu.
6. Depress +/INC Key to advance thru the Run Mode selection parameter prompt.
7. Depress +/INC Key to advance thru the Auto Logging Mode selection parameter prompt.
8. Depress +/INC Key to advance thru the Average Time selection parameter prompt.
9. Depress +/INC Key to advance thru the Alarm Setting parameter prompt.
10. Depress +/INC Key to advance thru Lamp Selection parameter prompt.
11. Depress +/INC Key to advance thru Response Factor Setting parameter prompt.
12. Depress RESET Key to initiate calibration sequence.
13. Depress-/CRSR Key to decline restoration of the backup calibration.
14. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet as illustrated in Figure 4.2.
15. Introduce Zero Air to Model 580B by opening flow regulator.

16. Depress RESET Key to "Zero" Model 580B.
17. Close Flow Regulator.

(C) Span Calibration - assuming that the Span gas has a concentration of 250 ppm isobutylene the following procedure is followed:

18. Simultaneously Depress RESET and -/CRSR Keys to activate the movable cursor.
19. Repeat Step 18 until the cursor is at the ones place.
20. Simultaneously Depress RESET and +/INC Keys to increment the ones place value.
21. Repeat Step 20 until the ones place value reads 0.
22. Repeat Step 18 to move cursor to the tens place.
23. Repeat Step 20 until the tens place value reads 5.
24. Repeat Step 18 to move the cursor to the hundreds place.
25. Repeat Step 20 until the hundreds place value reads 2.
26. Repeat Step 18 to move the cursor to the thousands place.
27. Repeat Step 20 until the thousands place value reads 0.
28. The LCD should now read:

    SPAN PPM = 0250
    "+" TO CONTINUE

29. Depress +/INC to accept the span conc. value.
30. Connect isobutylene cylinder (250 ppm) to calibration tubing assembly.
31. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet.
32. Introduce isobutylene standard to Model 580B by opening flow regulator.
33. Reset key to "CALIBRATE" Model 580B.
34. Close Flow Regulator.
35. Depress +/INC. Key in response to "RESET" TO CALIBRATE message.
36. Depress MODE/STORE to return to the Run Mode.

The instrument has been calibrated and is ready to make measurements.

4.5 DETERMINATION OF RESPONSE FACTORS

As mentioned above, the Model 580 can be calibrated with isobutylene but be set to read correctly, the concentration of another substance. This is done by using the Response Factor that is set in the parameter routine. The default for the response factor is 1.0. The Response Factor is the number that is multiplied by the measured concentration to obtain the correct concentration of the measured component. If the chemical to be measured is less sensitive on a PID than the standard, (usually isobutylene) then the Response Factor is greater than 1.0. If it is more sensitive than the standard then the Response Factor is less than 1.0.

The reason for a Response Factor is practicality. If it is know that the sample to be measured contains only benzene and therefore the user would like to read benzene concentration directly, there are two approaches. The user could make a bag standard daily of benzene vapor in air and calibrate the 580 directly. Or the Response Factor could be used. In the latter case a bag with benzene is made only once for comparison to a cylinder of a stable standard (such as isobutylene). Then daily, the Model 580 is calibrated with the cylinder standard, a simple operation compared to the work of preparing a bag standard.

As an example, if the bag containing 55 ppm benzene in air as prepared above were measured in a 580 calibrated against isobutylene, the concentration might have been read as 91 ppm. thus the 580 is more sensitive for benzene than for isobutylene.

The Response Factor can now be calculated as:

$$\text{Response Factor (RF)} = \frac{\text{Factor STD Concentration}}{\text{580 Reading of Factor STD}}$$

$$RF = 55/91 = 0.604$$

When 0.60 is entered into the 580 as the Response Factor, the 580 will read 55 ppm for the bag.

Now the 580 need only be calibrated using an isobutylene standard and a Response Factor of 0.60 to correctly respond to benzene.

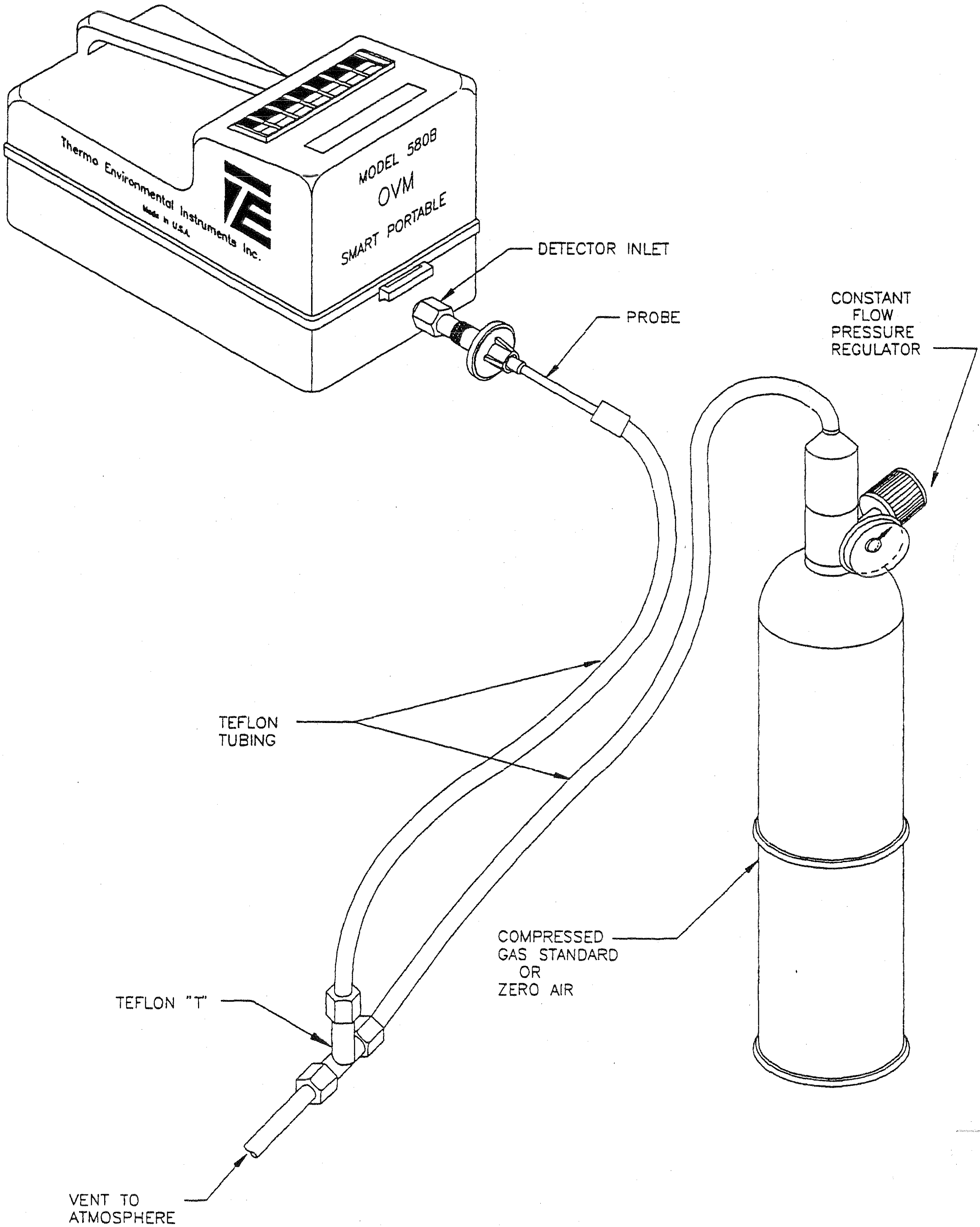


Figure 4.1
Cylinder Calibration

SOP No. S-18

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

PROCEDURES FOR SONIC DRILLING

STANDARD OPERATING PROCEDURE

PROCEDURES FOR SONIC DRILLING

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes methodologies for sonic drilling. This procedure includes the minimum required steps and quality checks that employees and subcontractors are to follow when drilling using this technique. This SOP addresses technical requirements and required documentation to be completed during sonic drilling.

2.0 SUMMARY OF METHOD

This subsurface exploration technique utilizes a dual-cased drilling system which uses mechanical vibration (between 50 and 150 Hertz). The dual-cased system uses an inner core barrel, an outer large-diameter drill pipe, and a drill bit that are advanced during drilling. Sonic drilling commonly utilizes the vibration in consortium with a slow rotation and down-pressure to advance the drill string. The drill bit generates sinusoidal vibration waves that cause a cutting action at the bit face.

The cutting actions include fracturing, shearing, or displacement f the subsurface materials. Displacement often occurs as the vibration fluidizes unconsolidated deposits causing the material to move away from the drill string. Most of the formation material however, enters the core barrel and is contained within distinct plastic tubes. Fracturing action is typically associated with drilling through cobbles and boulders, while shearing action is associated with drilling through elastic formations such as dense silt, clay, or shale.

Rotosonic/Rotasonic drilling is a modification of sonic drilling in which the core barrel is advanced sonically until full. The casing is then advanced sonically and in some cases with the use of water to cool the drill head and provide additional stability of the core upon retrieval. This method assists in reducing the overall system heat generation, which in turn prolongs equipment life, and reduces down time. However, the application of water increases the volume of IDW over traditional sonic drilling methods.

3.0 DEFINITIONS

Cleanout Depth – The depth to which the end of the drill string has reached after an interval of cutting.

Drill String – The complete air rotary/air hammer drill assembly including hammer/bit, casing collars and stabilizers, and drill casing.

Hoist Line – Wire rope used on the draw works to hoist and lower loose augers, the removable center plug, sampling rods and split barrel, or the down-hole sampling hammer assembly.

Mast – A load-bearing structure on a drilling rig used for supporting the rotation head, pulldown hydraulics, hoisting lines, etc. It must be constricted to safely carry the expected loads encountered in drilling and completion of wells of the diameter and depth for which the rig manufacturer specifies the equipment. To allow for contingencies, it is recommended that the rated capacity of the mast should be at least twice the anticipated weight of the load or normal pulling load.

Oscillator Housing – Uses two eccentric, counter-rotating balance weighs that are timed to direct 100% of the mechanical vibration energy at 0 degrees and 180 degrees to the drill pipe. An air spring system insulates the drill rig from the vibration. Counter balances produce resonant energy waves that minimize borehole friction on the drill string.

Dual-Casing System – A 4-inch to 8-inch diameter core barrel, which is advanced for sampling purposes with an appropriately sized (6- to 10-inch diameter) outer drill pipe (casing). Typically, the core barrel is advanced ahead of the drill pipe for the length of the core run. The outer pipe is then advanced over the core barrel to keep the hole open for core and barrel retrieval. The outer drill pipe may be kept in the ground once total depth has been reached and may be used as casing material for the installation of wells.

4.0 HEALTH AND SAFETY WARNINGS

As with any heavy equipment, caution should be taken to minimize the potential for injuries such as crushing and pinching. Additionally, the drill rig has overhead hazards and in most cases noise hazards which should also be considered. Before any drilling is completed, the rig should be set level and securely on its outriggers. If due to ground conditions additional must be placed under the outrigger, these shall consist of large wooden blocks. Drill operation with the drill tires/tracks in contact with the ground should be avoided.

All personnel shall be familiar with the location of the rig's emergency kill switch.

All non-essential personnel should be kept clear of exclusion zone or from an area surrounding the rig.

Due to the potential of noise hand signals should be developed for communication between engineer and the driller.

The drill platform is several feet from the ground, and itself presents a fall hazard. Engineers/geologist should spend minimal time on the driller's platform.

5.0 INTERFERENCES

Potential difficulties in using the sonic drilling technique include: the potential for downtime as a result of the complexity of the drill head mechanics; vibration may cause heat to develop which may result in loss of contaminants from samples or failure of the drill bit; fine-grained particles may migrate to the periphery of the core due to the vibratory action; and during retraction of the outer casing, the casing is vibrated which may cause the pin or box at the joints to fail resulting in casing remaining in the ground.

6.0 PERSONNEL QUALIFICATIONS

The drill operator should be licensed (if appropriate according to State regulations) or otherwise sufficiently experienced to operate the sonic drill rig. The driller's attendant should be sufficiently familiar with the rig operations to adequately assist the drill operator. The rig geologist/engineer should be sufficiently skilled in the drilling method and also be proficient in the classification of soils.

7.0 EQUIPMENT AND SUPPLIES

- A drill rig of sufficient horsepower, hoisting capacity, and torque to drill borings of sufficient width and depth as specified in work plans.
- The rig should have the drill pipe handling system built into the drill mast. Optionally, a support truck may be mobilized with an on-board crane system for handling the drill piping.
- Casing, bit, and core barrel of sufficient size.
- If lubricants are needed on rod joints, non-petroleum based lubricants will be used. If available, Teflon-based thread compound is recommended.
- A pump and tremie piping for pumping annular grout seal into he borehole.
- Appropriate decontamination equipment (steam cleaner, materials for a decon pad, etc.) as necessary.
- Drums for IDW containment as specified in the work plans.
- PPE and monitoring equipment as specified in the safety plan.
- Monitoring well construction materials as specified in the work plans.

8.0 PROCEDURES

8.1 Prior to drill mobilization to the boring location, the engineer/geologist shall assess the location for safety hazards such as sloping or uneven ground and underground and overhead utilities. An appropriate route to the location will be chosen based upon ease of access. The location will be moved if the presence of utilities or other hazards require it.

8.2 The drill operator and the engineer/geologist will inspect the drill equipment for proper maintenance and condition. Out-of-specification materials will not be utilized, or will be repair sufficiently.

8.3 Barriers or something similar to keep personnel away from the rig should be placed in accordance with the safety plan.

8.4 Once the site is prepared, the drill should be stabilized and leveled using the hydraulic outriggers. The mast should be raised slowly such that no shifting of the rig occurs.

8.5 The engineer/geologist shall observe and document the drilling operation and make certain that it is in compliance with all planning documents.

8.6 The geologist/engineer will log the soil lithology in accordance with SOP No. S-11 Procedures for the Description and Identification of Soils (See FSP Appendix B). A Soil Boring Log Field Data Record should be completed for each boring location (See FSP Appendix C).

8.7 Soil samples will be collected from plastic core tubes that are generated as part of the sonic drilling technique.

8.8 The engineer/geologist should conduct regular health and safety sampling of the boring location as specified in the safety plan.

If the boring is to be converted to a monitoring well, the well shall be constructed in accordance with SOP No. S-12 Monitoring Well and Piezometer Installation Procedures (See FSP Appendix B).

Once the boring/well installation is complete, the rig mast will be lowered, the outriggers will be lifted and the rig will be moved off of the boring location. All cuttings or other waste will be containerized or disposed of in accordance with planning documents. If the soil boring is to be abandoned, it shall be done in accordance with the applicable planning documents and appropriate State regulations.

9.0 DATA AND RECORDS MANAGEMENT

The following records will be generated by the site geologist or field sampler:

- Field Logbook entry
- Soil Boring Log Field Data Record
- Well Installation Diagram Field Data Record
- Standard penetration testing data
- PID Reading for soil for total volatile compounds (if collected)

10.0 QUALITY CONTROL/QUALITY ASSURANCE

Quality control of the drilling process shall be the responsibility of the engineer/geologist overseeing the drilling. The QA/QC shall consist of a verification that all procedures completed are in accordance with appropriate planning documents.

11.0 REFERENCES

Boart Longyear: http://www.boartlongyear.com

Prosonic Corporation: http://www.prosoniccorp.com/sonicdrilling.html

SOP No. S-19

MACTEC ENGINEERING AND CONSULTING, INC.
STANDARD OPERATING PROCEDURE

FIELD SAMPLE TRACKING SYSTEM

STANDARD OPERATING PROCEDURE

FIELD SAMPLE TRACKING SYSTEM

1.0 SCOPE AND APPLICATION

This purpose of this standard operating procedure (SOP) is to outline the steps associated with computerized field sample tracking of analytical samples collected during remedial investigations. This SOP includes computerized procedures applicable to tracking samples from label production through shipping samples to the lab with a completed Chain of Custody (COC). Specific steps and details are described for the primary tasks of initial sample creation, label production, post sample collection data entry and creation of COC for shipping to lab.

Additional manual sample tracking procedures and chain of custody forms may be utilized during investigations. These procedures only address those tasks that will use the computerized sample tracking program.

2.0 EQUIPMENT AND SUPPLIES

- PC Computer with Windows
- MS Access 97 or greater (2002 preferred)
- Copy of the MACTEC Field Sample Tracking Program
- Printer
- Avery 5260 Labels

3.0 METHOD SUMMARY: FIELD SAMPLE TRACKING PROGRAM OVERVIEW

To start the Field Sample Tracking Program double-click the Field Sample Tracking Program shortcut on your computer desktop. This will start Access and load the Field Sample Tracking Program. When it starts you will see the main form you will use for creating labels and tracking samples (see figure 1). From here you can add new samples, add methods to samples, print labels, track the status of samples, print COCs and Analysis Request Forms (ARFs) and assign samples to a Sample Delivery Group (SDG).

The upper area of the form contains information about the sample such as by whom, when and where it was collected. Below the sample information is a box containing the analysis method information for the sample. Each analysis will have a method name, status, bottle information SDG and fraction. **The status field is used to track where in the sample collecting and shipping process the analysis is located**. It will change at every step of the sample tracking process.

You can also move through the samples using the form navigation buttons at the bottom of the form. The left and right arrows will jump you one sample forward or backward and the arrows with a line will take you to the first or last sample, respectively. The arrow with an asterisk is the Add New Sample Button, which will be used later. There are also 2 buttons that allow you to quickly navigate the samples if you know the Field Sample Identification (ID) or the sample number.

To jump to a sample if you know the Field Sample ID, enter it in the text box next to the Go To Field Sample ID button (or select it from the drop down) and press the button. Note that this will take you to the first occurrence of the field Sample ID, if it happens to be listed more than once.

To jump to a sample if you know the Sample Number, enter it in the text box next to the Go To Sample Number button (or select it from the drop down) and press the button.

To the right of the sample information is a box containing radio selection buttons, two buttons labeled “Selected” and “All” and two buttons with arrows. The two buttons with arrows can be used to move to the next sample forward or backward in the list. The radio selection and the “Selected” and “All” buttons are used to change the status field for a method. Their use will be explained in the following sections.

4.0 PROCEDURE

4.1 Initial Sample Creation

This step can be done for the majority of the samples using the sample information found in the task specific work plans. Individual samples can be created as necessary (see figure 1).

- Press the Add New Sample Button
- Enter the Field Sample ID, Location ID and Sample Date if known.

- Select Sample Team, QC Code, Matrix and Media from drop down selections
- Add new methods (see add new methods section)

Underline spaces may be used if sample depth is a part of the Field Sample ID, but is unknown at the time of the sample creation. The correct Field Sample ID can be entered after the sample is collected.

After the sample is created, the analytical methods needed are added. The Field Sample Tracking Program method list is dependant on Matrix, so make sure Matrix has been selected before adding methods to a sample.

- Press the Add New Methods Button – this will open a selection form (see figure 2).
- Select methods to add to the sample by checking the box to the left of method name.
- When you have selected all methods you wish to add, press the Add Methods Button.

You will return to the Field Sample Tracking Screen and the added methods will now be in the method box. Their status is initially set to "NEW".

4.2 Label Production

Methods that will have labels printed need to have a status of "PRINT".

For methods with a Status of "NEW" use the following recipe:

- Navigate to a sample you wish to print labels for.
- Set the Radio button in the upper left box to "Print".
- If you wish to print labels for all methods for the sample, press the All Button.
- If you wish to print less than all of the methods, check the box next to the method name you wish to print. When you have selected the methods you wish to print, press the Selected button.

Repeat this process for all samples that you wish to print labels for.

In addition, you can manually change the status to “PRINT” for any method by using the drop down selector in the status field. This may be done to reprint labels that have already been printed before.

When you have finished identifying all of the methods that need to print labels, press the Close and Print Labels Button.

Press the Print Labels and Return to Main Form Button that appears. A preview of the labels to be printed will appear for your review. If it looks satisfactory, press the print icon and close the preview. The labels will start printing on the printer containing the Avery 5260 Labels. If the print preview on the screen is not satisfactory, just close the preview.

A Message box with the Choice “Change PRINT Status of Analyses” will appear. Choose the CHANGE button if you samples have printed to your satisfaction. This will change the method status to “PRINTED”. If you choose “KEEP” the status will remain at “PRINT” and the methods will show up in the next batch of labels. Use this option if you find an error in your preview, experience a printer error, or just wanted to print a test page of labels.

4.3 Post Sampling Data Entry

After a sample is collected in the field, it needs to be recorded as “Checked in to the Office” (or field trailer or where ever the field tracking computer is being operated).

For methods with a Status of “PRINTED” use the following recipe:

- Navigate to a sample you wish to check in.
- Enter information about sample date and time in the sample collection section.
- Enter information about sample depth, if appropriate.
- Set the Radio button in the upper right box to “Check-in to Office”.
- If you wish to check in all methods for the sample, press the “All” Button.
- If you wish to check in less than all of the methods, check the box next to the method name you wish to check in. When you have selected the methods you wish to check in, press the “Selected” button.

- Edit the In field of a method if less than the number of required bottles has returned – if necessary (due to bottle breakage, less than enough sample material).

Repeat this process for all samples that you wish to check in.

In addition, you can manually change the status to “IN LAB” using the drop down selector in the status field.

4.4 Off-Site Laboratory Samples

Sample containers will be weighed by the off-site laboratory sample manager immediately upon receipt at the off-site laboratory. The sample manager will record the container identification number and post-sampling container weight on the chain of custody. A trip blank will accompany each shipment of samples to the off-site laboratory. The trip blank will consist of a sample container with methanol prepared by the off-site laboratory for the same analytical method as the field samples.

4.5 COC Production and Sample Shipping

For methods with a Status of “IN LAB” use the following recipe:

- Navigate to a sample you wish to ship to a lab.
- Set the Radio button in the upper right box to “Send to Lab”.
- If you wish to ship all methods for the sample, press the “All” Button.
- If you wish to ship less than all of the methods, check the box next to the method name you wish to ship. When you have selected the methods you wish to ship, press the “Selected” button.

Repeat this process for all samples that you wish to ship to a lab.

In addition, you can manually change the status to “SHIP” using the drop down selector in the status field.

When you have finished identifying all of the methods that need to be shipped to a lab, press the Close and Print ARF/COC Button.

Press the Print COC/ARF and Return to Main Form Button that appears. A preview of the COC/ARF to be printed will appear for your review. If it looks satisfactory, press the print icon and close the preview (see figure 3 for an example of a printed COC). If not satisfactory, just close the preview.

A Message box with the Choice “Change Status of Analyses from SHIP to SHIPPED” will appear. Choose the CHANGE button if you samples have printed to your satisfaction. This will change the method status to “SHIPPED”. If you choose “KEEP” the status will remain at “SHIP” and the methods will show up in the next batch of COC/ARF to ship. Use this option if you find an error in your preview or just wanted to print a COC/ARF test page.

5.0 FIGURES

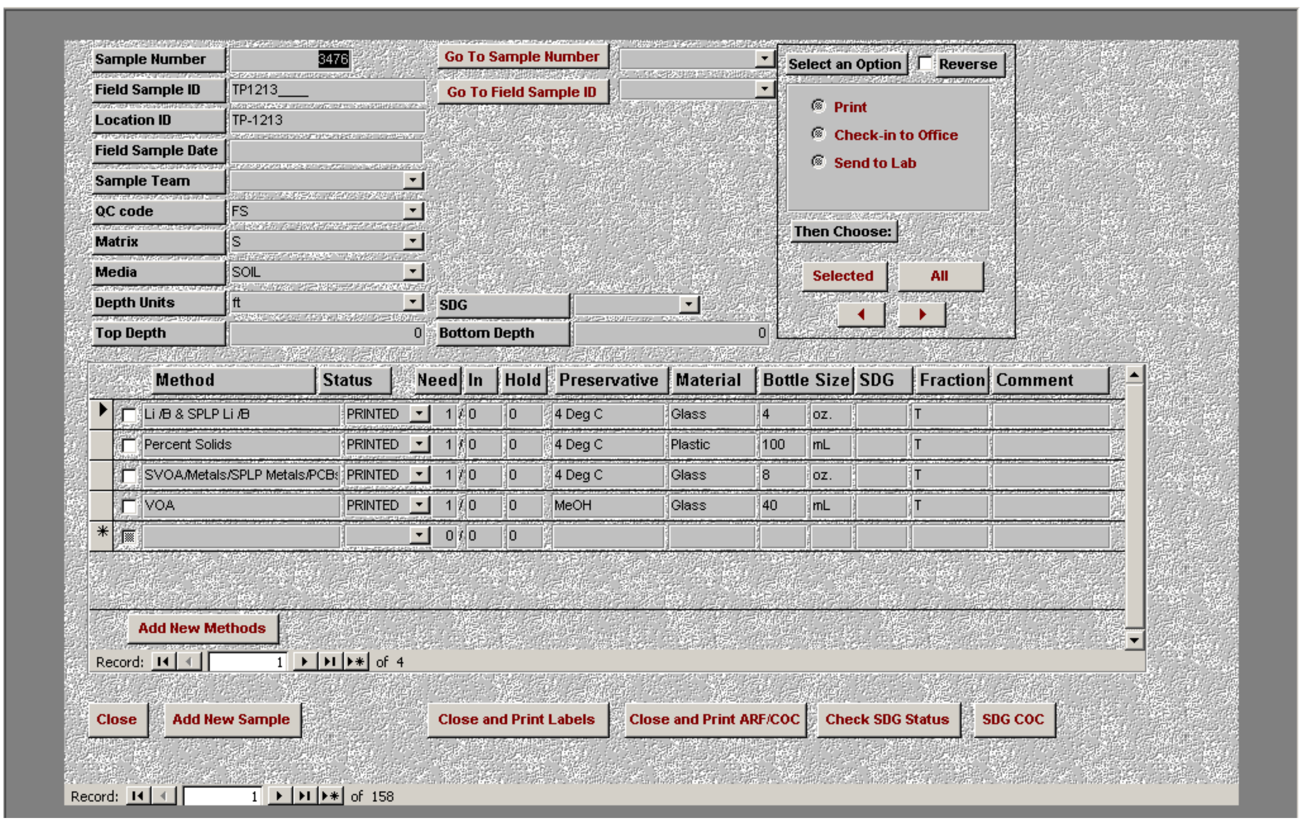
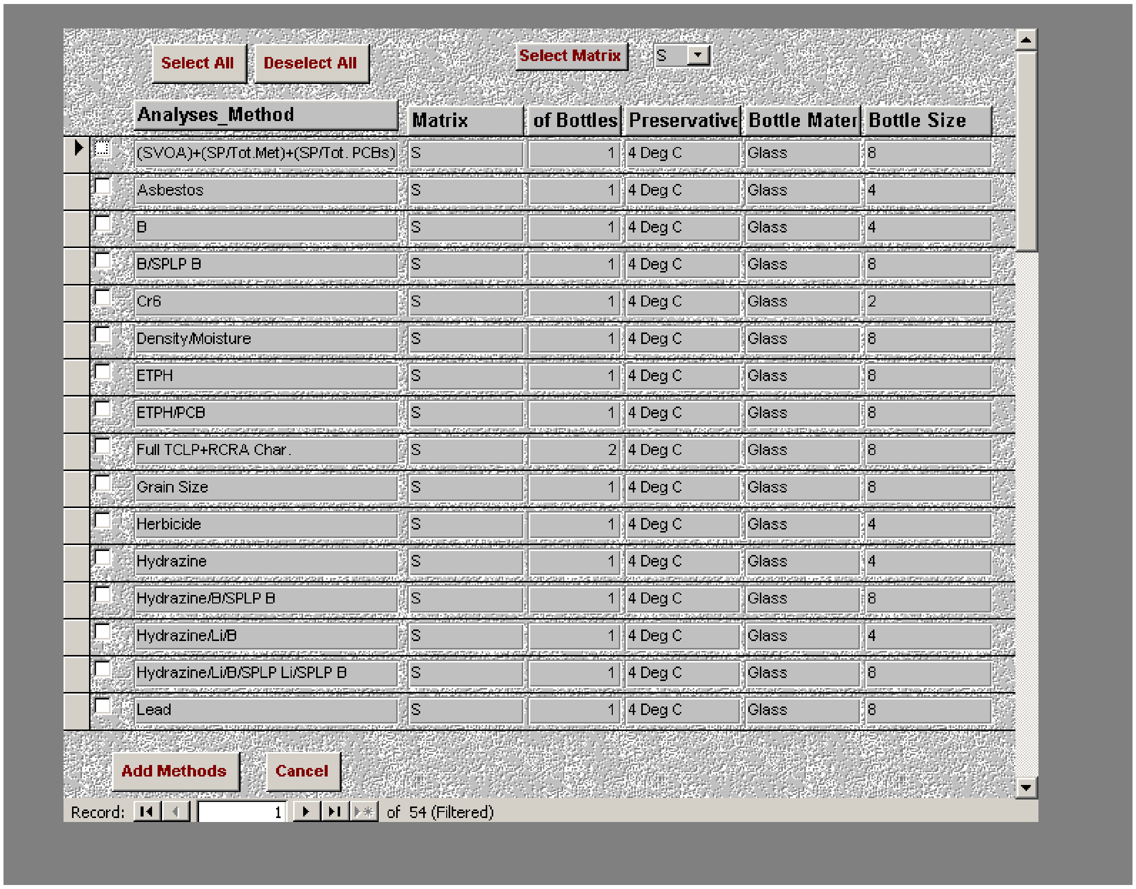


Figure 1



Select All | Deselect All | Select Matrix | S

Analyses_Method	Matrix	of Bottles	Preservative	Bottle Mater	Bottle Size
(SVOA)+(SP/Tot.Met)+(SP/Tot. PCBs)	S	1	4 Deg C	Glass	8
Asbestos	S	1	4 Deg C	Glass	4
B	S	1	4 Deg C	Glass	4
B/SPLP B	S	1	4 Deg C	Glass	8
Cr6	S	1	4 Deg C	Glass	2
Density/Moisture	S	1	4 Deg C	Glass	8
ETPH	S	1	4 Deg C	Glass	8
ETPH/PCB	S	1	4 Deg C	Glass	8
Full TCLP+RCRA Char.	S	2	4 Deg C	Glass	8
Grain Size	S	1	4 Deg C	Glass	8
Herbicide	S	1	4 Deg C	Glass	4
Hydrazine	S	1	4 Deg C	Glass	4
Hydrazine/B/SPLP B	S	1	4 Deg C	Glass	8
Hydrazine/Li/B	S	1	4 Deg C	Glass	4
Hydrazine/Li/B/SPLP Li/SPLP B	S	1	4 Deg C	Glass	8
Lead	S	1	4 Deg C	Glass	8

Add Methods | Cancel

Record: 1 of 54 (Filtered)

Figure 2

Figure 3 Computer Generated Chain Of Custody

Eastland Wollen Mill Superfund Site

Site QAPP
Corinna Maine

Lab:

Sample #	Sample Date	Sample Time	Field Sample ID	Qty Total	Qty Each	Bottle Size and Material		Preservative	Media	Method	Fraction
2501	8/21/2003	10:00	GW0710	5							
					2	1 L	Amber G	4 Deg C	GW	SVOA/PAH SIM	T
					3	40 mL	Glass	HCL, 4 Deg C	GW	VOA	T
2511	9/10/2003	9:00	GW0904	6							
					2	1 L	Amber G	4 Deg C	GW	SVOA/PAH SIM	T
					1	500 mL	Plastic	Sulfuric Acid p	GW	Hydrazine	T
					3	40 mL	Glass	HCL, 4 Deg C	GW	VOA	T

SDG Number: CY005 *Start Date: __/__/____* *End Date: __/__/____*

Relinquished:______________ Date: __/__/____ Time:____ Received:______________ Date: __/__/____ Time:____

Relinquished:______________ Date: __/__/____ Time:____ Received:______________ Date: __/__/____ Time:____

Date Printed: Tuesday, December 02, 2003 *Page 1 of 1*

Figure 3

SOP No. S-20

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF SURFACE WATER VELOCITY AND DISCHARGE

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF SURFACE WATER VELOCITY AND DISCHARGE

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes recommended procedures and methods to be used for the measurement of water velocity (V) and/or discharge (Q) during surveys of flowing water bodies (rivers and streams). These procedures are intended for and applicable to shallow rivers and streams (with a depth less than 3 feet where the measurements or observations can be conducted by wading.

1.1 Summary of Method

A surface water discharge Field Data Record (FDR) (See FSP Appendix C) must be completed for each sampling location. A working knowledge of the sampling equipment to be used is a basic requirement for understanding surface water flow sampling procedures.

Familiarity with the applicable surface water flow sampling guidelines and the project FSP and Work Plan objectives is required. Familiarity with the site-specific health and safety plan (HASP) is required prior to conducting surface water flow sampling procedures. All procedures should be reviewed prior to initiating field activities.

There are four components discussed in this SOP: Site Selection, Methods and Equipment, Measurement and Documentation, and Calculation.

1.2 Site Selection

The intended sampling location(s) may be predetermined (fixed), new (first time measurement) or dynamic (ad hoc or one-time). Depending upon the sample location, the measurement of stream flow may require direct and multiple in-stream measurements of flow or the simple observation or measurement of water stage (depth) relative to a surveyed gauge and datum for those locations where a stage-discharge relationship has been previously determined.

Predetermined or fixed discharge sampling locations should be located via map, survey coordinates (i.e., GPS), photograph, or fixed guides (i.e., staff gauge, survey posts, flume, culvert, etc.) and should be consistent with pervious sampling events. Deviation from previously used sampling locations due to obstruction, hazards, or flow conditions should be thoroughly documented.

Carefully consider potential health and safety hazards that may be present. The associated Project or Site Health and Safety Plan (HASP) should be consulted and followed. Specific consideration should be given to the use of Personal Flotation Devices (PFDs) as water depth or flow conditions warrant.

All sampling sites should be inspected before taking flow measurements. Carefully select flow sites that will allow for the most accurate flow measurements. Site selection should consider the following:

1. Constricted stream segments are usually the most convenient and allow greater accuracy because the construction reduces the width of each stream subsection (if employed) and increases the current velocity. In-stream flow restricting structures (e.g., culverts, weirs, etc.) may be preferred if flow turbulence is not significant.
2. The stream stretch chosen for measurement should be relatively straight (without bends). Adequate access to both sides of the stream channel is usually required.
3. Flow sites should have a uniform flow and should be free of eddies, slack water, and excessive turbulence.
4. The streambed section selected for measurement should be free of boulders, cobbles or aquatic vegetation. Obstructions in the stream may need to be removed both at the measurement site and immediately upstream of the flow site. The removal of obstructions allows for more accurate flow measurements and should not affect the actual stream discharge.
5. Select stream segments that will be accessible during both low and high stream flow conditions. Consider the expected seasonal changes in stream flow and vegetation growth.
6. The water flow velocity decreases with depth below the water surface due to the resistance from the stream bed. Estimating the average stream

velocity based upon surface flow velocity will over estimate the actual average flow velocity through the selected stream segment.

1.3 Methods and Equipment

This section describes the recommended methods and equipment required to obtain surface water flow measurements.

1.3.1 Methods

There are three general methods that can be used for measuring flowing surface water velocity and discharge: surface water stage/depth, time-of-travel, and current-meter flow measurement.

1. Surface water stage/depth involves measuring water flow depth relative to a surveyed datum or gauge. This method is applicable for those locations where a depth versus discharge relationship has been established and is most commonly used in flow restricting or control structures (weirs, spillways, etc.). Typically a permanent graduated depth gauge is installed at these locations.
2. Time-of-travel measurements can provide rough estimates of water velocity and consists of dropping a buoyant object in the stream reach under observation, and noting the time required for them to float an estimated distance. The velocity estimates are generally too inaccurate for use in interpretation of data or final reporting, but can be useful in preliminary planning of studies and in subsequent more precise measurements. Surface water velocity is greater than the average for the entire stream, and a correction factor must be applied to the surface velocity. An average flow velocity of about 85 percent of that of the surface velocity is a reasonable rule-of-thumb value.
3. The current-meter measurement method includes the summation of the products of individual subsection areas of the chosen stream cross section and their respective average velocities. It is assumed that the measured flow velocity at each vertical sample point along the stream cross section represents the mean velocity in the individual subsection areas. This sub-section method may not be suitable or applicable under certain flow conditions, such as through flow restricting structures

(culverts, weirs, etc.) or during low flow conditions. However, a current-flow meter may still be used for measuring flow velocity through flow restricting structures.

1.3.2 Equipment

Recommended minimum flow-measurement equipment (for current-meter based flow measurements) includes:

- Current meter or flow meter appropriate for the expected flow conditions;
- Top-setting wading rod (marked in tenths of a foot), or equivalent;
- Tape measure or tagline (marked in tenths of a foot); and
- Logbook and/or FDR (waterproof recommended) and indelible marker.

The following are recommended additional or optional equipment:

- Waterproof waders or boots;
- Personal flotation device (PFD), and any other Personal Protective Equipment (PPE), as required per applicable Site or Project Health and Safety Plan (HASP) protocols;
- Digital camera;
- GPS unit; and
- Stakes, hammer and flagging (for location marking), if needed. Commonly used current meter or flow meter brands include: Marsh-McBirney electronic, Price pygmy (with timer and beeper), Price meter, Type AA (with Columbus weight) or YSI Flow/Tracker Handheld ADV. Other equivalent brands may also be used. In order to have the most flexibility when using a meter, consider using meters that measure flow at a variety of depths and can be attached to a wading rod or a long staff. Consult the manufacturer or vendor-supplied documentation for the recommended range of flow conditions (i.e., flow depth) prior to field use.

1.4 Measurement and Documentation

A summary description of the conventional current-meter flow measurement procedure (mid-section method to determine discharge) is presented here for general guidance. The documentation of field activities is also discussed in this section.

1.4.1 Flow Measurement

The general procedures for measuring stream flow using the current-meter flow measurement method are as follows (see attached Figure 1 for reference):

1. Establish the sampling location as discussed in Section 1.2 above.
2. Secure the end of a tag line (or tape measure) to the right bank of the stream (facing downstream).
3. Extend the line across the stream and secure the other end of the line to the left bank. Assure that the line is perpendicular to the stream flow. This line will define the stream segment or transect for measurement.
4. Make sure that the tape is tight and numbers are visible.
5. Read and record the tape measurements corresponding to both the left and right edges of the water and calculate the total width of the stream.
6. Determine and record the spacing or width of the vertical subsections. If possible, space the vertical divisions so that no subsection has more than 10 percent of the total discharge. As a general guideline, if the stream width is less than 5 ft, use vertical spacing widths of 0.5 ft. If the stream width is greater than 5 ft, the recommended minimum number of subsections is 10 to 25. Local conditions may dictate the proper number of subsections.
7. While it is generally easier if subsections are of equal width, it may be necessary to vary the subsections widths if the flow varies significantly along the transect. Subsections may be narrower where the depth and velocity is highest.
8. Starting at the right edge of the water and standing on the downstream side of the tape, move along the tape to the first subsection.
9. Measure and record the depth (from the water surface) and the tape measure length. The wading rod should be kept vertical and the flow sensor kept perpendicular to the tape rather than perpendicular to the flow while measuring velocity with an electric flow meter. When using a pygmy meter, the instrument should be perpendicular to the flow.
10. If the depth is greater than 2.5 feet, measure the velocity at two points in each vertical at depths corresponding to two-tenths and eight-tenths the total depth.
11. If the depth is less than 2.5 feet, measure velocity at a depth of six-tenths the total depth.
12. Do not stand in a position that interferes with the current. It is recommended that the current meter be placed at least three inches downstream from the tape measure and that the analyst stand at least 1.5 feet downstream from the meter if possible.
13. Repeat steps 8 through 11 above at each subsection. Continue these procedures until reaching the left edge of the water.

14. Do not change or substitute current meters during a transect. If a meter malfunctions mid-way through a cross-section, then repeat the entire transect. It is recommended that the same type of current meter be used during subsequent surveys at the same site.
15. The streambed profile may include isolated instances of extreme depth or shallowness. It is best not to change meters to accommodate these few extremes. The flow in an extremely shallow portion of an otherwise deep stream is usually not a significant portion of the total flow, so skipping extremely shallow measurements may not introduce significant error in the readings. However, the number and extent of all shallow subsections that prevent accurate flow measurements should be documented.

The purpose of the top setting wading rod is to allow the user to easily set the sensor at 20%, 60%, and 80% of the total depth. The total depth can be measured with a depth gauge rod or other similar graduated and rigid device. If the water depth is less than 2.5 feet, only one measurement is recommended within each measurement section. To set the sensor at 60% of the depth, line up the foot scale on the sliding rod with the tenth scale on the top of the depth gauge rod. For example, if the total depth is 2.0 feet, then line up the 2 on the foot scale with the 0 on the tenth scale. If the depth is greater than 2.5 feet, two measurements should be taken at 20% and 80% of the total water depth. To set the sensor at 20% of the depth, multiply the total depth by two. For example, the total depth is 2.7 feet the rod would be set at 5.4 feet. Line up the 5 on the foot scale and the 4 on the tenth scale.

1.4.2 Documentation

All field activities should be thoroughly documented in writing. Supplementary documentation may include photographs, video recordings or audio recordings. Documentation should include instrument calibration information (if applicable) and the collection of all field measurement data.

1.4.2.1 Instrument Calibration

Document any calibrations procedures for each instrument unit and any field test or analysis performed. Link these records with the associated field measurements. Calibration may be performed by the equipment vendor or manufacturer prior to use. Retain vendor certifications of all factory-calibrated instrumentation (if supplied). Calibration-related documentation should include the following:

1. Record manufacturer name, model number and identifying number such as a serial number for each instrument unit.
2. Document any corrective actions taken to correct the instrument performance.
3. Note any incidence of discontinuation of use of the instrument due to instrument or calibration failure.
4. Describe or cite the specific calibration or verification procedure(s) as performed. Proper reference to factory or vendor calibration procedures may be adequate.

1.4.2.2 Field Measurement Data

Record the following minimum information in writing in the field log book and/or FDR during the collection of all surface water flow measurement data:

- Project name;
- Date and time of each measurement or test;
- Location of the measurement (assigned station number or other description);
- General observations such as weather conditions, stream flow conditions, etc. Note any conditions that may affect the collection of accurate field measurement data;
- Handheld GPS latitude and longitude of sampling location (if required);
- All measurement values;
- Proper and consistent reporting units,
- Names of all analysts performing the measurements and all observers;
- Unique identification of the specific instrument unit(s) used for the test(s) (i.e., instrument serial numbers, etc.), and
- Description of any digital photographs collected of the sampling location or conditions, if applicable.

1.5 Calculation

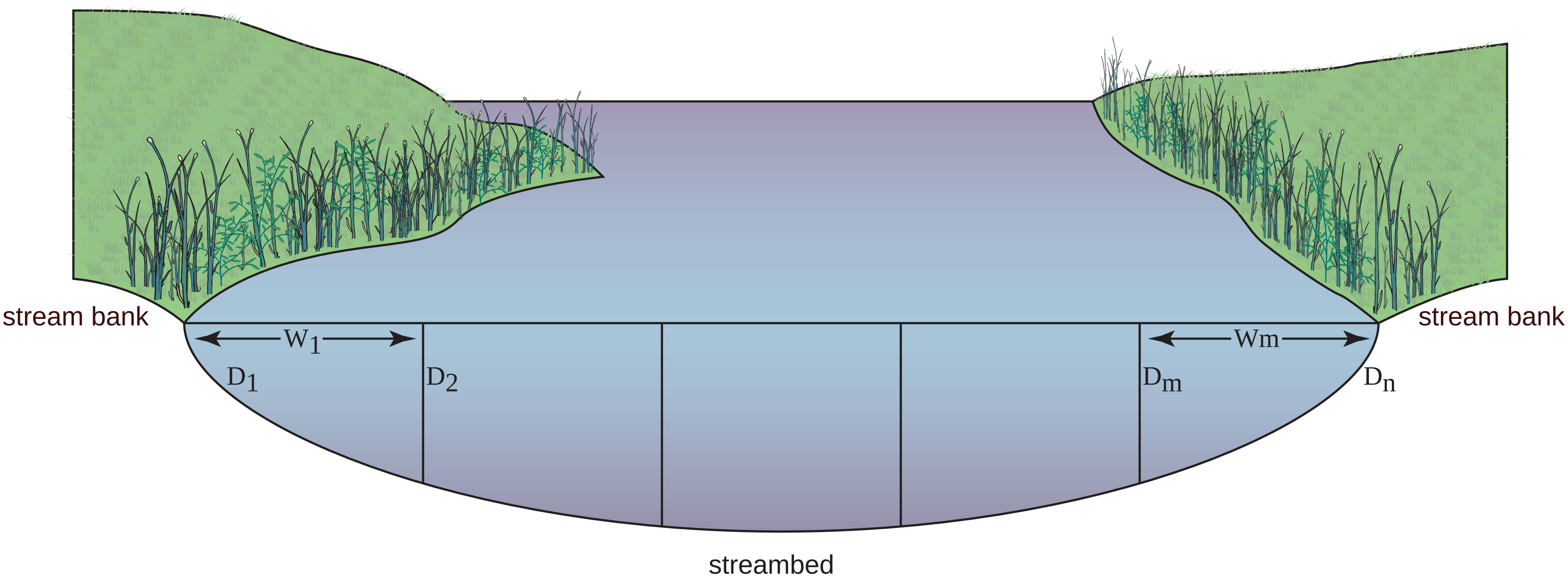
Once the subsection velocities, depths, and distance of the cross section (transect) have been determined, the midsection method can be used for determining the discharge (see formula in Figure 1). Compute the discharge in each increment by multiplying the averaged velocity or single velocity in streams less than 2.5 ft deep in each increment by the increment width and averaged depth (or single depth in streams less than 2.5 ft deep). (Note that the first and last increments are located at the edge of the stream and have a depth and velocity of zero.) Add the discharges for each increment to compute total stream discharge. Record the flow in liters (or cubic feet or cubic meters) per second in your field book and Field Data Record form (example attached), if required.

1.6 Selected References

Rantz, S.E., Measurement and Computation of Streamflow: Volumes 1 and 2. Measurement of Stage and Discharge, U.S. Geological Survey Water-Supply Paper 2175, 1982.

U.S. Environmental Protection Agency, Standard Operating Procedure for Streamflow Measurement, Compiled by Forrest John, United States Environmental Protection Agency, Region 6, Dallas, Texas.

DRAFT



$$Q = \left(\frac{D_2 + D_1}{2}\right)\left(\frac{V_2 + V_1}{2}\right)W_1 + \ldots + \left(\frac{D_m + D_n}{2}\right)\left(\frac{V_m + V_n}{2}\right)W_m$$

Q = discharge, D = depth, V = velocity, W = width (after Rantz and others, 1982)

GEOMEGA 11/9/07 C06433F Olin	Stream cross section illustrating mid-section method to determine discharge.	**Figure** 1

BL o:\Olin\07 Statistical Report\streambedX-sec.ai

SOP No. S-21

STANDARD OPERATING PROCEDURE

GENERAL PROCEDURE FOR INDUCTION LOGGING IN WELLS

STANDARD OPERATION PROCEDURE

GENERAL PROCEDURE FOR INDUCTION LOGGING IN WELLS

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the use of induction logging in monitoring wells. Induction logging may be used to determine spatial and temporal changes in electrical conductivity in the subsurface due to dissolved contaminants in groundwater. This SOP is intended to compliment (not replace) information, procedures and guidelines as supplied by the logging equipment vendor and/or manufacturer and associated equipment-specific procedures.

2.0 EQUIPMENT

The following equipment and supplies are recommended prior to initiating field activities:

2.1 MEASUREMENT SPECIFIC SUPPLIES

- Induction log probe (Geonics EM 39, or equivalent)
- Wire line winch system compatible with the log probe
- Tripod and pulley apparatus
- Field-capable computer or data logger with the required software for the logging system
- 12V battery (fully charged)
- 12V to AC inverter
- Keys and necessary tools to open wells
- Duct tape
- Water level meter

2.2 FIELD DATA AND RECORD KEEPING SPECIFIC SUPPLIES

- Field notebook and pen with indelible ink
- Well construction details for the well(s) to be logged (total depth, etc.)

2.3 DECONTAMINATION SUPPLIES

- Deionized (DI) water

- Alconox™ detergent, or equivalent
- Paper towels

2.4 HEALTH AND SAFETY EQUIPMENT

As required per site Health and Safety plan

3.0 PREPARATION

The induction log probe requires calibration prior to each field deployment. This calibration may be performed by the vendor from which the equipment has been supplied or may be performed per the manufacturer's guidelines separately prior to each logging project. Instrument calibration should be performed per vendor- or manufacturer-supplied procedures and guidelines.

Verify the charge status of the 12V battery (fully charged).

Before proceeding to the first well to be logged, set up all equipment to be used in the field (12V battery, inverter, wire line console, probe, and computer or data logger) and verify that the signal is being received and recorded.

4.0 PROCEDURES

4.1 Open the well cap and check the wellhead and breathing space atmosphere for worker health (as required by the applicable Site Health and Safety Plan). Record the results if measurements are collected. Take appropriate respiratory precautions (including leaving the area) if conditions warrant.

4.2 Measure and record the groundwater water level below the top of casing or other established datum. Measure to the nearest 0.01 foot, unless specified otherwise by the Site work plan or Data Quality Objectives (DQO). Compare the result to historic values, if available, and note any significant deviations.

4.3 Verify the total depth (TD) of the well from completion logs or other validated data source. The total depth of the well may be measured using the water level probe.

4.4 Connect all associated equipment (probe, cable, PC/data logger, inverter, battery) per manufacture's and/or vendor's guidelines, and before turning power on to the logging unit.

4.5 Turn the power on to the logger (Note: **NEVER** attach probe to cable with power on!).

4.6 Lower probe into the well and set the point where the probe and cable attach at the surveyed measuring point of the well casing. This is the point at which the depth measurements will be "zeroed" and must be set consistently so that previous and subsequent logging data can be compared. Use the tripod and pulley system as allowed by local site and well construction conditions.

4.7 Open the data logging software and follow the on-screen procedures to zero the depth, set the desired sampling interval (0.1 ft is recommended), and create a data file with a unique file name. Verify that an ASCII-format data file is being created so that data can be accessed by appropriate software for post processing.

4.8 Record the time, well or location ID, and data file name in the field log book or field recording form.

4.9 Activate the winch to lower the probe down the well, adjusting the speed so that the system can acquire quality data at a specified sampling rate (10 ft/min. is recommended for 0.1 ft sampling interval). Monitor the software display to ensure that data is being received and recorded.

4.10 Monitor the depth of the probe to ensure that excess cable slack is not generated when probe reaches the bottom of the well.

4.11 When the probe reaches the bottom of the well, stop the winch and, if desired, close the data file. A new data file may be created for recording the data when the probe is raised from the well. Alternatively, the file may be kept open and recording as the winch is stopped and reversed with the ascending data separated during post-processing.

4.12 Closely monitor the depth of the probe as it is being raised to ensure that it is stopped before it reaches the top of the well.

4.13 When the logging is complete close and save the data file before removing the probe. Also verify that the file contains appropriate data before removing the probe from the well. Re-log the well if needed.

4.14 **TURN OFF POWER TO PROBE AND DISCONECT POWER SUPPLY BEFORE DISASSEMBLING SYSTEM! <u>NEVER REMOVE THE PROBE FROM CABLE WITH THE POWER ON!</u>**

4.15 If necessary, decontaminate the probe with Alconox™ solution and DI water rinse. The cable may be decontaminated by holding a wet rag on the cable as the tool is being retrieved, but care must be taken not to interfere with the function of the depth recording apparatus on the winch.

4.16 Secure the well and record the time in the log book or field data form. Also record any pertinent observations made during the logging that may affect data processing and interpretation.

4.17 At the earliest convenience, backup recorded logging data from the data logger or computer onto other media (from data logger to computer, from computer to USB flash drive, etc.) to minimize the potential for data loss or corruption prior to data analyses.

APPENDIX C

Field Data Records

APPENDIX C
FIELD DATA RECORDS

Aquifer Testing Completion Checklist
Chain of Custody
Field Instrument Calibration Record
Low Flow Groundwater Sampling
Monitoring Well Log – Above Ground Mount
Monitoring Well Log – Flush Mount
Rock Coring Logs
Soil Boring Log
Surface Soil Sampling
Surface Water/Sediment Sampling
Test Pit Record
USCS Key to Soil Descriptions
Well Development Record

FIELD DATA AQUIFER TESTING COMPLETION CHECKLIST

DATE: _____________ AQUIFER TEST NO. _______

SETUP	DATA	BY WHOM
MONITORING WELL ID		
DATE OF TEST		
TYPE OF TEST		
HERMIT TYPE/SERIAL#		
TEST #		
DATA COLLECTION RATE		
TRANSDUCER		
SERIAL #		
PSIG		
SCALE FACTOR		
OFFSET		
LINEARITY		
INPUT CHANNEL		
TEST DATA		
INPUT MODE (TOC/SUR)		
STATIC WATER LEVEL (FT./TOC)		
WELL DEPTH (FT./TOC)		
XD DEPTH (FT.TOC)		
INITIAL XD REFERENCE		
SLUG DIAMETER (INCHES)		
SLUG LENGTH (FEET)		
SLUG BOTTOM DEPTH (FT./TOC)		
TIME OF SLUG PLACEMENT		
TIME OF WL EQUILIBRATION		
NEW XD REFERENCE		
START TIME OF TEST		
END TIME OF TEST		

NOTES: ______________________________

TestAmerica, Inc.
Chain of Custody Form

●53 Southampton Road
Westfield, MA 01085
(P) 413-572-4000
(F) 413-572-3707
Westfield

●148 Rangeway Road
N. Billerica, MA 01862
(P) 978-667-1400
(F) 978-667-7871
Boston - Service Center

Client:	Client Project #:	Job#	Quote#	PO#
Address:	Site ID & State:	Shaded areas for office use	Comments (Special Instructions)	
	Reports Sent To:	Invoice same as Report to? ☐		
Phone: Fax:	Email: Email Rpt: ☐	If Invoice contact or address different, note in *Comments*	Please print legibility. If the analytical requests are not clearly defined on the chain-of-custody, the turnaround time will begin after all questions have been satisfactorily answered.	

Requested Turnaround Time (PLEASE SPECIFY)

STANDARD ______ **RUSH** ______ ***(Lab Approval Required)***

Regulatory Programs/Presumptive Certainty/QC Forms

MADEP MCP ☐ GW1/S1 ☐ PWS DEP Forms ☐
CTDEP RCP ☐ CT RSR ☐ EDD Required ☐
QA Rpt: No QC ☐ Std QC Rpt ☐ CLP QC Rpt: ☐

500-series for drinking water
600-series for waste water, NPDES
6000-series for groundwater, soil, waste
8000-series for groundwater, soil, waste
Use comments section to further define.

Sample Type Codes: WW-Wastewater, DW-Drinking Water, SW-Surface Water, GW-Groundwater, LW Lab Water, A-Air, "Z"-Other (please specify)

Sample I.D.	Sample Type	Sampler's Initials	Date / Time Collected	Grab	Comp.	# Containers	Plastic(P) or Glass(G)	Preservative: NaHSO4/MeOH	HNO3 to pH <2	H2SO4 to pH <2	HCl to pH <2	NaOH to pH >12	Na2S2O3	None / 4º C	524 / 8260	525 / 624 / 8270	625	PCB / Pest / Herbicide	EPH / VPH	DRO / GRO / ETPH	Metals (Please Specify)	Mercury	General Chemistry	Bacteriological	Toxicity				*Comments:*

Sampled by (print):			Signature:			**Cooler ? Y / N** — **MADEP Requirement Samples Iced? Y / N**
Relinquished by:	Date:	Time:	Received by:	Date:	Time:	**Temp @ receipt:** ________ **ºC**
Relinquished by:	Date:	Time:	Received by:	Date:	Time:	**Preservation / pH checked? Y / N**
Relinquished by:	Date:	Time:	Received by:	Date:	Time:	**By:**________**Date:**________

TestAmerica WESTFIELD

Page_____ of _____

White = Lab file Yellow = Report copy Pink = Customer copy

FIELD INSTRUMENTATION CALIBRATION RECORD

PROJECT: Olin Chemical Superfund Site | DATE: ______ | TIME: ______

CREW ID OR TASK ID: ______ | JOB NUMBER: ______

SAMPLER SIGNATURE ______________________ CHECKED BY ______________

EQUIPMENT CALIBRATION			INITIAL CALIBRATION		SECONDARY CALIBRATION (see note 3)		
MANF & MODEL NO.______			STANDARD	METER	STANDARD	METER	ACCEPTANCE
UNIT ID NO.______			VALUE	VALUE	VALUE	VALUE	CRITERIA **
	pH	units	______	______	______	______	+/- 10% of standard
	Redox	+/- mV	______	______	______	______	see note 1
	Conductivity	mS/cm	______	______	______	______	+/- 10% of standard
	DO	mg/L *	______	______	______	______	+/- 10% of standard
	Thermometer Temperature	deg. C	______	______	______	______	+/- 2.0 deg. C
TURBIDITY							
METER TYPE______		NTU (low)	______	______	______	______	within 0.5 NTU of
MODEL NO.______							the standard
UNIT ID NO.______		NTU (high)	______	______	______	______	+/- 10% of standard
PHOTOIONIZATION		Background					
METER TYPE______		ppmv	______	______	______	______	within 5 ppmv of Zero
MODEL NO.______							
UNIT ID NO.______		Span Gas ppmv	______	______	______	______	+/- 10% of standard
OTHER METER TYPE______							
MODEL NO.______							
UNIT ID NO.______			______	______	______	______	see note 2

Check One

☐ Equipment calibrated within the Acceptance Criteria specified for each of the parameters listed above.

☐ Equipment (not) calibrated within the Acceptance Criteria specified for each of the parameters listed above (see notes below).

MATERIALS RECORD

	Source and Lot Number
Deionized Water Source: ______	pH ______
PID SPAN Gas: Lot ______	ORP ______
PID Zero Gas: Lot ______	Conductivity ______
Other : ______	Turbidity ______
	Other ______

NOTES:

* = Indicate in notes section what was used as the DO standard (i.e., based on saturation at room temperature)

** = If the meter reading is not within acceptance criteria, clean or replace probe and re-calibrate, or use a different meter if available. If project requirements necessitate use of the instrument, clearly document on all data sheets and log book entries that the parameter was not calibrated to the acceptance criteria.

1 = meter must read within specified range of the Zobell solution.

2 = specify acceptance criteria in the Notes section

3 = secondary calibration to be completed should instrument drift be suspected during field day

FIELD DATA RECORD - LOW FLOW GROUNDWATER SAMPLING

PROJECT: Olin Chemical Superfund Site
FIELD SAMPLE NUMBER:
JOB No.:
Location:
SITE TYPE: WELL
DATE:
ACTIVITY: START END
SAMPLE TIME:

WATER LEVEL / PUMP SETTINGS

MEASUREMENT POINT
- [ ] TOP OF WELL RISER
- [ ] TOP OF PROTECTIVE CASING

PROTECTIVE CASING STICKUP (FROM GROUND): FT
CASING / WELL DIFFER.: FT

INITIAL DEPTH TO WATER: FT
WELL DEPTH (TOR): FT
PID AMBIENT AIR: PPM
WELL DIAM.: IN

FINAL DEPTH TO WATER: FT
SCREEN LENGTH: FT
PID WELL MOUTH: PPM

WELL INTERGRITY:

	YES	NO	N/A
CAP	___	___	________
CASING	___	___	________
LOCKED	___	___	________
COLLAR	___	___	________

DRAWDOWN VOLUME: GAL
(initial - final x 0.16 {2-inch} or x 0.65 {4-inch})

RATIO OF DRAWDOWN VOLUME TO TOTAL VOLUME PURGED:

PRESSURE TO PUMP: PSI

TOTAL VOL. PURGED: GAL
(purge volume (milliliters per minute) x time duration (minutes) x 0.00026 gal/milliliter)

REFILL SETTING:
DISCHARGE SETTING:

PURGE DATA

TIME	DEPTH TO WATER (ft)	PURGE RATE (ml/m)	TEMP. (deg. c)	SPECIFIC CONDUCTANCE (umho/cm)	pH (units)	DISS. O2 (mg/L)	TURBIDITY (ntu)	REDOX (mv)	COMMENTS

EQUIPMENT DOCUMENTATION

TYPE OF PUMP
- [ ] GEOPUMP (peristaltic)
- [ ] SMCO BLADDER
- [ ] BLADDER

TYPE OF TUBING
- [ ] TEFLON OR TEFLON LINED
- [ ] HIGH DENSITY POLYETHYLENE
- [ ] OTHER ___________________

TYPE OF PUMP MATERIAL
- [ ] Polyvinyl chloride
- [ ] STAINLESS STEEL
- [ ] OTHER ___________________

TYPE OF BLADDER MATERIAL
- [ ] TEFLON
- [ ] Other ___________________

ANALYTICAL PARAMETERS

Check if Scheduled for Collection	METHOD NUMBER	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED (Check if collected)
[ ] VOC	USEPA-8260B	HCL / 4 DEG. C	3 X 40 mL	[ ]
[ ] SVOC	USEPA 8270C	4˚C	2 X 1 LAG	[ ]
[ ] NDMA	EPA 1625	4˚C	2 X 1 LAG	[ ]
[ ] NDMA	EPA 625	4˚C	2 X 1 LAG	[ ]
[ ] TAL Metals	USEPA 6010B/6020/Hg 7470A	pH<2 HNO_3 4˚C	1 X 500 mL	[ ]
[ ] Hex-Chromium	USEPA 7196A	4˚C	1 X 500 mL	[ ]
[ ] Nitrate, nitrate, chloride, sulfate	USEPA 300	4˚C	1 x 500 mL P	[ ]
[ ] SULFIDE	USEPA-376.1	Zinc Acetate/NaOH	1 X 250 mL P	[ ]
[ ] ALKALINITY	USEPA-310.1	4˚C	W/SULFATE	[ ]
[ ] Ammonia	USEPA-350.1	pH<2 H_2SO_4 4˚C	1 X 1L poly	[ ]
[ ]				[ ]
[ ]				[ ]
[ ]				[ ]
[ ]				[ ]

Purge Observations

Purge Water Conatinerized yes no

Number of Gallons Generated ___________

LOCATION SKETCH

SIGNATURE: ____

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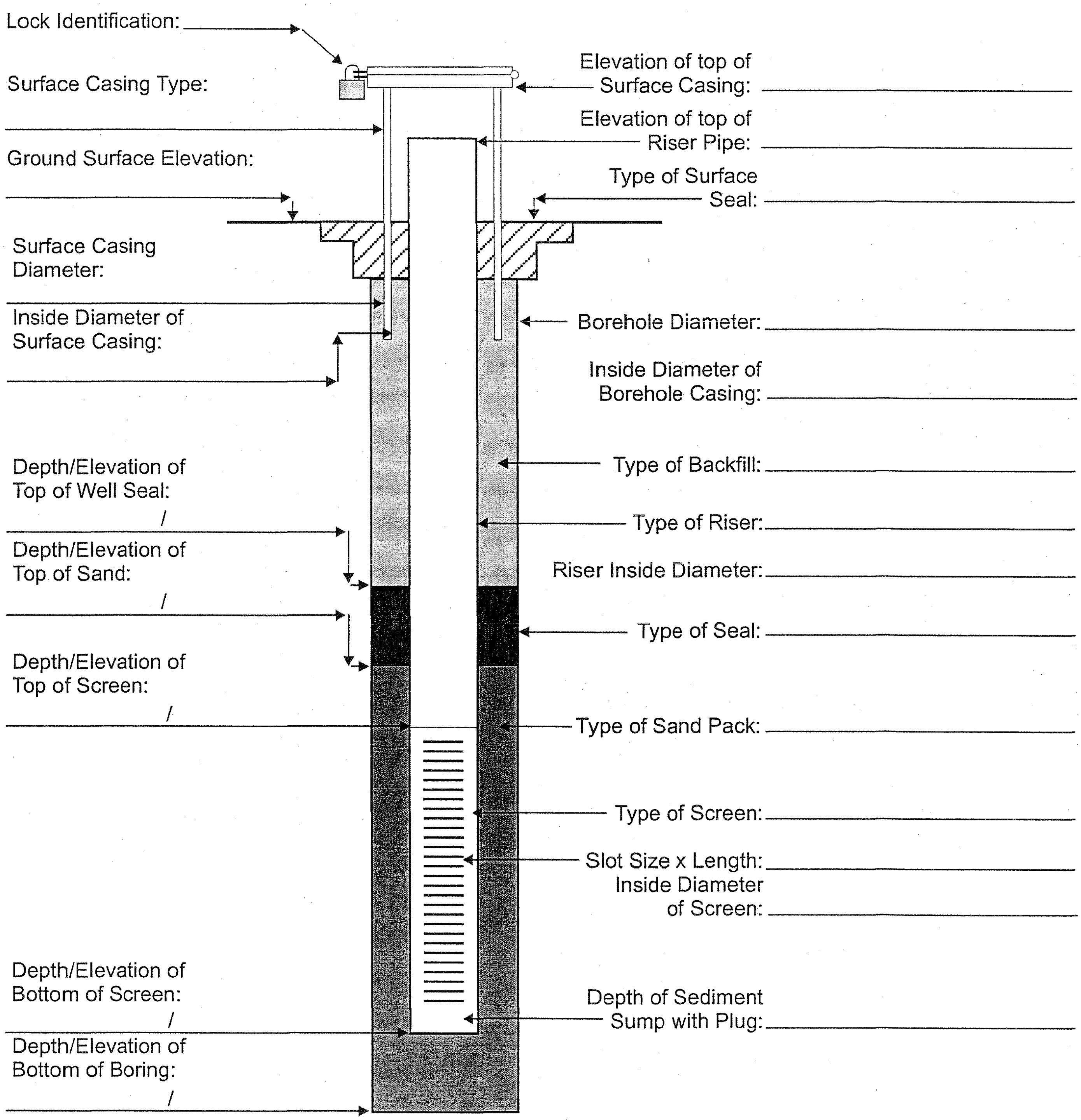
Monitoring Well Log (Stick Up Type)

Well No.:

Project No.:		Project Name:	
		Project Area:	
Contractor:	Driller:	Method:	
Logged By:		Date Started:	Completed:
Checked By:	Date:		



Not To Scale

FIGURE

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Monitoring Well Log (Flush Mount Type)

Well No.:

Project No.:		Project Name:	
		Project Area:	
Contractor:	Driller:	Method:	
Logged By:		Date Started:	Completed:
Checked By:	Date:		

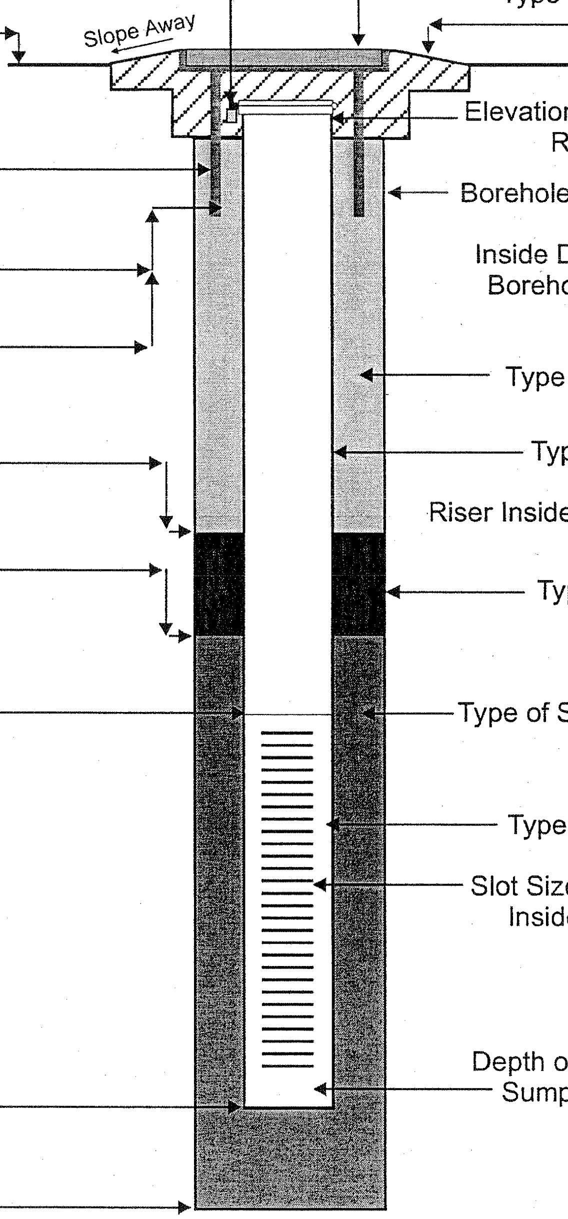
Lock Identification: ____________

Elevation of top of Surface Casing: ____________

Type of Flush Mounted Water-tight Cover: ____________

Ground Surface Elevation: ____________

Type of Surface Seal: ____________



Surface Casing Diameter: ____________

Elevation of top of Riser Pipe: ____________

Inside Diameter of Surface Casing: ____________

Borehole Diameter: ____________

Surface Casing Type: ____________

Inside Diameter of Borehole Casing: ____________

Type of Backfill: ____________

Depth/Elevation of Top of Well Seal: / ____________

Type of Riser: ____________

Depth/Elevation of Top of Sand: / ____________

Riser Inside Diameter: ____________

Type of Seal: ____________

Depth/Elevation of Top of Screen: / ____________

Type of Sand Pack: ____________

Type of Screen: ____________

Slot Size x Length: ____________

Inside Diameter of Screen: ____________

Depth/Elevation of Bottom of Screen: / ____________

Depth of Sediment Sump with Plug: ____________

Depth/Elevation of Bottom of Boring: / ____________

FIGURE 2-7

Not To Scale

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Rock Coring Log

Boring/Well No:

Project No.:	**Project Name:**	**Checked By:**		
Client Name:	**Logged By:**	**Protection Level:**	**Ground Elevation:**	
Drilling Contractor:	**Drilling Method:**	**Driller's Name:**		
Bit Type/Size:	**Soil Drilled:**	**Rig Type:**	**Start Date:**	**Finish Date:**
Core Interval (to/from)(ft.):	**P.I.D. (eV):**	**Casing Size**	**Auger Size:**	

Depth (feet) Below Ground Surface	Sampling No. & Penetration/ Recovery (feet)	RQD (%):	Graphic Log	Core Breaks		Rock Description and Comments on Drilling
				Type:	Dip:	

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MACTEC	Project: Olin Chemical Superfund Site Location: Client:	Boring: File No.:

Contractor:	Drilling Method:	**Definitions:** **S** = Split Spoon Sample **U** = Thin Wall Tube Sample **R** = Rock Core Sample **V** = Insitu Vane Shear Test q_p = Unconfined CompressiveStrength (psf) **woh** = weight of 140 lb. hammer **wor** = weight of rods **wc** = Water Content, percent **oc** = Organic Content, percen
Operator:	Bore Hole ID/OD:	
Logged By:	Auger ID/OD:	
Checked By:	Sampler:	
Date Start/Finish:	Hammer Wt./ Fall:	
Boring Location:	Water Level[3]:	
Ref. Elevation[1]:		

Depth	Sample Information: Sample No.	Recovery	Time	Sample Description and Classification	Unified Classification	Analytical Collected (Y/N)	Elevation

Notes

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

Page

Boring:

MACTEC ENGINEERING AND CONSULTING

FIELD DATA RECORD - SURFACE SOIL SAMPLING

PROJECT Olin Chemixal Superfund Site JOB NUMBER DATE

SAMPLE LOCATION ACTIVITY TIME START END SAMPLE TIME

FIELD SAMPLE NUMBER QC SAMPLES: duplicate ______ EQ BLK ______ MS/MSD: yes no

SURFACE SOIL DATA

DEPTH OF SOIL: TOP BOTTOM

	TYPE OF SOIL:	EQUIPMENT FOR COLLECTION	DECON FLUIDS USED
TYPE OF SAMPLE ☐ DISCRETE	☐ ORGANIC	☐ HAND CORER	☐ DI WATER N2 PURGE
☐ COMPOSITE	☐ SAND	☐ S.S. SPOON	☐ POTABLE WATER
SAMPLE OBSERVATIONS	☐ GRAVEL	☐ ALUMINIUM PAN	☐ LIQUINOX
ODOR ______	☐ CLAY	☐ SHOVEL-SPATULA	☐ OTHER ______
COLOR ______	☐ OTHER ______	☐ OTHER ______	

ANALYTICAL PARAMETERS

SOIL	METHOD NUMBER	PRESERVATION METHOD	BOTTLE TYPE VOLUME REQUIRED	Notes:
☐ VOC	8260	DI and MEOH	2-low & 1-high	
☐ SVOC	8270	4°C		
☐ NDMA	mod 8270	4°C		
☐ TAL METALS	6000/7000	4°C		
☐ Hex-Chromium	3060A/7196A	4°C		
☐ opex-kempore	mod 8000	4°C		
☐				
☐				
☐				
☐				

NOTES

SAMPLED BY: ______

RECEIVED BY: ______

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FIELD DATA RECORD - SURFACE WATER/ SEDIMENT SAMPLING

PROJECT: Olin Chemical Superfund Site   JOB NUMBER: ____   DATE: ____

FIELD SAMPLE NUMBER: ____   ACTIVITY TIME: START ____ END ____   Sample Time: ____

QC SAMPLES COLLECTED: ____

SURFACE WATER DATA

WATER DEPTH AT LOCATION: ____ FT   SPEC. COND: ____ mS/CM

DEPTH OF SAMPLE FROM SURFACE: ____ FT   D.O.: ____ PPM

TEMPERATURE: ____ DEG C   SALINITY: ____ PPM

TURBIDITY: ____ NTUS   ORP: ____ mV

PH: ____ UNITS   Associated field Dup: ____   Equip BLK: ____   MS/MSD: Yes

EQUIPMENT USED

- ☐ BEAKER/Bottle
- ☐ PACS BOMB
- ☐ PERISTALTIC PUMP
- ☐ FILTER/ NUMBER ____
- ☐ OTHER- ____

TYPE OF SURFACE WATER

- ☐ STREAM/ RIVER
- ☐ LAKE/ POND
- ☐ SEEP
- ☐ MARSH
- ☐ OTHER ____

DECON FLUIDS USED:

- ☐ DI WATER
- ☐ POTABLE WATER
- ☐ ____

SEDIMENT DATA

DEPTH OF SEDIMENT: ____

TYPE OF SAMPLE: ☐ DISCRETE ☐ COMPOSITE

SAMPLE OBSERVATIONS

ODOR ____

COLOR ____

TYPE OF SEDIMENT:

- ☐ ORGANIC
- ☐ SAND
- ☐ GRAVEL
- ☐ CLAY
- ☐ TALCOSE ____
- ☐ OTHER ____

EQUIPMENT FOR COLLECTION

- ☐ HAND CORER
- ☐ S.S. SPOON
- ☐ Shovel-Trowel
- ☐ DREDGE
- ☐ OTHER ____

DECON FLUIDS USED

- ☐ DI WATER
- ☐ POTABLE WATER
- ☐ LIQUINOX
- ☐ OTHER ____

Associated field Dup: ____   Equip BLK: ____   MS/MSD: Yes

ANALYTICAL PARAMETERS

WATER

		METHOD NUMBER	FILTERED	PRESERVATION METHOD	VOLUME REQUIRED	Notes:
☐	VOC	8260		pH<2 HCL 4°C	3 X 40 mL	
☐	SVOC	8270		4°C	2 X 1L AG	
☐	NDMA	EPA 1625		$Na_2S_2O_3$ 4°C	2 X 1L AG	
☐	TAL METALS	6000/7000		pH<2 HNO_3 4°C	1 500 mL poly	
☐	Hex-Chromium	3060A/7196A		4°C no Headspace	1 500 mL poly no Headspace	
☐	opex-kempore	mod 8000		4°C	3X 40 mL vial	
☐	____	____	____	____	____	
☐	____	____	____	____	____	
☐	____	____	____	____	____	

ANALYTICAL PARAMETERS

SOIL

		METHOD NUMBER	PRESERVATION METHOD	VOLUME REQUIRED	Notes:
☐	VOC	8260	DI and MEOH	2-low (DI) & 1-high (MEOH)	
☐	SVOC	8270	4°C	1 8 oz	
☐	NDMA	mod 8270	4°C	1 8 oz	
☐	TAL METALS	6000/7000	4°C	1 4 oz	
☐	Hex-Chromium	3060A/7196A	4°C	1 4 oz	
☐	____	____	____	____	
☐	____	____	____	____	
☐	____	____	____	____	

NOTES

SIGNATURE: ____

RECEIVED BY: ____

TEST PIT RECORD

Project Name:_______________________ Geologist:_______________________ Test Pit Number: _______________

Project Number:_____________________ Date:___________________________ Checked By/Date:_______________

DEPTH (FT.)	0	5	10	15
0				
5				
10				
15				

Location Sketch

N

Total Depth: _______________

Depth to Water _______________

Samples Collected: _______________

____

____

____

Excavating Co.: _______________

Geologist/date: _______________

Notes:

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511 Congress Street Portland, ME 04101

TEST PIT RECORD

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KEY TO SOIL DESCRIPTIONS AND TERMS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, clean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations: (in this order)

Color (Munsell color chart)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Density/Consistency (from above, based on SPT "N" Value)
Moisture (dry, damp, moist, wet, saturated)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Geologic Origin (till, marine clay, alluvium, etc.)
Unified Soil Classification Designation

Sample Container Labeling Requirements:

Site:
Boring Number: Blow Counts:
Sample Number: Sample Recovery:
Sample Depth: Personnel Initials:

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Consistency is rated according to standard penetration resistance.

Descriptive Term (Modified Burmister System)	Portion of Total
trace	0% - 10%
little	10% - 20%
some	20% - 35%
adjective (e.g. sandy, clayey)	35% - 50%

Density of Cohesionless Soils	Standard Penetration Resistance N-Value (blows per foot)
Very loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.

Consistency of Cohesive soils	SPT N-Value blows per foot	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	0 - 2	0 - 250	Fist easily Penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	4 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	8 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	15 - 30	2000 - 4000	Indented by thumbnail
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

$$RQD = \frac{\text{sum of the lengths of intact pieces of core* >100mm (0.3ft.)}}{\text{length of core advance}}$$

*Minimum NQ rock core (1.88 in. OD of core)

Quality Description	RQD
Very Poor	<25%
Poor	25% - 50%
Fair	50% - 75%
Good	75% - 90%
Excellent	>90%

Desired Rock Observations: (in this order)

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Lithology (igneous, sedimentary, metamorphic, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90)
- -spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m)
- -tightness (tight, open or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and Rock Mass Description (very poor, poor, fair, etc.)
Recovery

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511 Congress St. Portland Maine

WELL DEVELOPMENT RECORD

Project:	Well Installation Date:		Project No.
Client:	Well Development Date:	Logged by:	Checked by:
Well/Site I.D.:	Weather:	Start Date:	Finish Date:
		Start Time:	Finish Time:

Well Construction Record Data:

Well Diameter ______ in.

Bottom of Screen ______ ft.

Sediment Sump/Plug ______ ft. — From Ground Surface ❑ From Top of Riser ❑

Screen Length ______ ft.

Fluids Lost during Drilling ______ gal.

Protective Casing Stick-up ______ ft. Protective Casing/Well Diff. ______ ft. PID Readings: Ambient Air ______ ppm; Well Mouth ______ ppm

Well Levels:

Initial ______ ft.

End of Development ______ ft.

24 Hours after Development ______ ft.

Sediment:

Well Depth before Development ______ ft. (from top of PVC)

Well Depth after Development ______ ft.

Sediment Depth Removed ______ ft.

HT of Water Column ______ ft. x ❑ 1.68* gal./ft. ❑ ______ = ______ gal./vol.
*for 4" HSA Installed Wells

Equipment:

- ❑ Dedicated Submersible Pump
- ❑ Surge Block
- ❑ Bailer ❑ 2" ❑ ________
- ❑ Grundfos Pump 2" _____ 4" _____

Approximate Recharge Rage ______ gpm

Total Gallons Removed ______ gal.

Well Development Criteria Met:

Notes: ______________________________

____

____

____

End of Well Development Sample (1 pint) Collected? Yes ❑ No ❑

	Yes	No
■ Well water clear to unaided eye	❑	❑
■ Sediment thickness remaining in well is <1.0% of screen length	❑	❑
■ Total water removed = a minimum of 5x calculated well volume plus 5x drilling fluid lost	❑	❑
■ Turbidity < 5NTUs	❑	❑
■ 10% change in field parameters	❑	❑

Water Parameter Measurements

Record at start, twice during and at the end of development (minimum):

Time	Volume	Total Gallons	pH	Temp.	Conductance	Turbidity	Pumping Rate

Well Developer's Signature ______________________________

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